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Post-Deployment Morbidity, Mortality, and Other Adverse Outcomes

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13. ABSTRACT (Maximum 200 Words) This project evaluates the utility of the Total Army Injury and Health Outcomes Database (TAIHOD) in investigating risk factors for Gulf War Illnesses (GWI) and, in particular, the etiologic role of stress. We have demonstrated that deployed veterans were, in the prewar period, happier and more satisfied than their non-deployed peers, suggesting that if stress is an important risk factor for illness it is likely due to stressors that occurred during or after the war and not to prewar selection bias. We have documented trends in rates of hospitalizations for Gulf War Illnesses (GWI) over a twenty-eight year period, extending the analysis back ten years earlier than originally planned. This trendline shows rates of hospitalizations for symptom-based conditions common among deployed veterans from 1970-1998 and highlights several sources of bias that emphasize the need for careful interpretation of hospitalization data. We have created proxy measures for life stressors and distress (e.g., changes in marital status or number of dependents, occupational problems or prewar health problems) that may partially explain the elevated rates of symptom-based illnesses prevalent among GWE veterans. We hypothesize that stress associated with these experiences may exacerbate the stress associated with deployment.				
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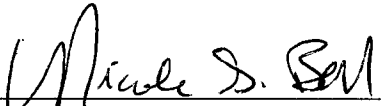
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5. Introduction

This report details our research activities for the period from June 25, 1999, through June 24, 2000. The purpose of our study is to:

- evaluate the strengths and weaknesses of the Total Army Injury and Health Outcomes Database (TAIHOD) as a tool for studying deployment related health and specifically the health of Gulf War Era (GWE) veterans,
- use TAIHOD data to evaluate the etiologic role stress may play in the illnesses experienced by GWE veterans,
- document long-term rates of illnesses common among GWE veterans but which may also be common among soldiers deployed to other settings at other points in time.

Much of our effort in the first year of our grant was spent obtaining and linking data to the TAIHOD, examining the content, structure, and sources of data for each dataset, and cleaning data. Through this process we learned that many of the prewar HRAs we had expected would be available for analysis could not ultimately be confirmed as unique responses by active duty Army soldiers. We were, however, able to conduct some analyses that suggest that Army soldiers who were deployed to the Gulf were happier and more satisfied with life in the prewar period than their non-deployed counterparts. Though tight control of type I and type II errors limits our ability to completely rule out chance as a possible explanation for this association, the consistent direction and magnitude of this association is suggestive. In contrast, deployed veterans appear to have been at greater risk for injury and risk-taking behaviors in the prewar period than their non-deployed peers. While a large number of pre- and postwar HRA surveys would be desirable to a full assessment of stress as a predictor of Gulf War illnesses, we have been able to adjust our approach to focus on alternative sources of information that may shed light on the influence of life and occupational stress and distress as predictors, or modifiers of the health and well-being of GWE veterans. In this second year of our grant, we have focused on identifying alternate sources of information on sources of stressors or distress, continuing our efforts to evaluate and validate data in the TAIHOD, and on extending and enhancing the analysis of temporal trends in illness rates for conditions prevalent among GWE veterans. One analytic effort currently underway uses GWE veterans' demographic and financial compensation records to measure life stressors in the prewar period (e.g., changes in marital status, change in number of dependents, frequency of changes, deviation from the mean number of years spent on active duty as compared to other soldiers of the same rank). These factors, as well as other demographic information, health utilization data (e.g., prewar hospitalizations), and deployment status will be used to model the risk for experiencing a "Gulf War-prevalent illness" (i.e., a symptom-based, ill-defined condition often reported by veterans of the Gulf War) in the postwar period. A similar analytic effort will focus solely on deployed GWE veterans and will add, to the previously described model, hypothesized war or deployment-related stressors (e.g., time spent in the Gulf, having a spouse on active duty who is also deployed, presence in the Gulf during periods of hostile fire). This second effort may include combat stress reactions and other stress-related conditions as outcomes, rather than focusing solely on a definition of Gulf War Illnesses that comprises only symptom-based conditions. This slight modification to the outcome measure would address the concerns voiced by many presenters at the Leadership and Operational Stress Conference held recently at Fort McNair, Washington D.C. At this conference several presenters noted their concerns about stress-related reactions and how they threaten a unit's effectiveness during deployments. Moreover, many presenters and commentators from the audience articulated the need for more information that might help to identify soldiers likely to be at risk for combat stress reactions and to identify potential modifying factors that might reduce or exacerbate this problem. Finally, we are completing another analytic effort that documents trends in hospitalization rates from 1970-1998 for the symptom-based conditions commonly reported by deployed Gulf War veterans. To these data we are adding information about other deployments and events that we hypothesize could influence rates for Gulf War-prevalent conditions. We expect to complete these analyses in August 2000. Preliminary results and drafts pertaining to all of these efforts are summarized in the text below and contained in the appendices.

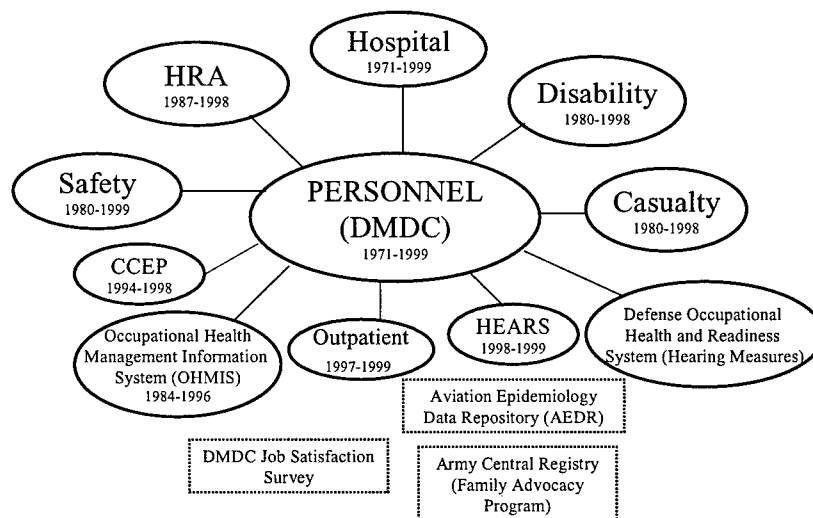
6. Gulf War Annual Progress Report

This section of this report describes our research efforts in more detail with specific reference to relevant Statement Of Work (SOW) objectives. We also address the broader aims of our study, noting our most significant accomplishments and findings. As directed, we are including both positive and negative findings and results from these efforts.

Background

The TAIHOD comprises several linked data sources including hospitalizations, deaths, disabilities, Gulf War activation files (documenting dates and duration of deployment to the Persian Gulf), health evaluations from the Comprehensive Clinical Evaluation Program (CCEP), Health Risk Appraisal (HRA) and Health Assessment Enrollment Review (HEAR) surveys of self-reported health behaviors, and personnel files for all Army soldiers who have been on active duty since 1971 (see Figure 1). A key purpose of this study was the evaluation of the TAIHOD as a research tool for the study of deployment related health, and in particular the potential etiologic role of stress in the development of Gulf War Illnesses (GWI). To this end we have devoted considerable resources to the scrupulous collection and linkage of data with the potential to shed light on the role of stress and other factors in predicting GWI among Gulf War Era (GWE) veterans. We have examined and critically reviewed the individual datafiles and sources of information, many of which are used not only by our team but also by other research teams working in the Gulf War Illness arena. Findings from these efforts are both discouraging and inspiring.

Figure 1. The Total Army Injury and Health Outcomes Database (TAIHOD)



In the first year we collected and linked all available Army Health Risk Appraisal (HRA) surveys to the TAIHOD. After careful review of the HRA surveys and data, however, we determined that many surveys were duplicates or near duplicate responses for the same individual; some could not be linked to Army personnel records; many surveys were clearly taken by family members (spouses or children) and yet carried the Social Security Numbers (SSNs) of the active duty servicemember, making it challenging to parse out the true identity of the respondent. We took a restrictive approach to qualifying survey responses (as described in our 1999 annual report). While this most certainly resulted in a reliable

* The CCEP was established in June 1994, upon the directive of the Department of Defense, in order to evaluate Gulf War veterans who were concerned about their health, and to facilitate treatment for the myriad of complaints and conditions experienced by Gulf War veterans.

database it unfortunately reduced the number of HRAs available for analysis of prewar health behaviors and stressors among GWE veterans. Table 1 shows the raw number of HRAs available in the prewar period and the number that were available after the validation process was completed, for all Army soldiers on active duty, and for deployers and nondeployers separately.

Table 1. Prewar HRA survey responses matched to Army soldiers on active duty during Operations Desert Shield/Desert Storm, before and after validation, for all active duty Army soldiers and stratified by deployment status.

	Total	Number of HRA survey responses matched	Number of validated HRA survey responses*
Number of soldiers on active duty in June 1990, December 1990, and June 1991	836,438	697	393
Deployed to Gulf	269,797	210	107
Not deployed to Gulf	566,641	487	286

* Number of HRA survey responses matched to active duty Army soldiers, after deleting duplicate responses and responses provided by spouses/dependents.

Another discouraging aspect to our work was the discovery that many of the data sources that have been used by other researchers have undergone little or no validation testing. The deployment activation files that indicate whether a soldier was, in fact, actually deployed to the Persian Gulf have not, to our knowledge, been evaluated for accuracy and completeness. In our last report we described our preliminary investigation of a possible collaborative arrangement with other Gulf War research teams to try to validate these data. Resource constraints have not allowed us to do more than propose this as an important objective for future pursuit. In the mean time, however, we did investigate another approach that might partially validate the deployment activation files, by comparing the DMDC Gulf War activation records that document deployment with the CCEP questionnaire item (#122) that specifically queries respondents about whether or not they were deployed to the Gulf. Unfortunately CCEP managers made an administrative decision to delete this item as they believed responses to any of a list of items specific to exposure in the Gulf was indicative of having been actually deployed. Following their logic, we have been able to conduct some matching using these exposure-based questions. Results from this effort are presented in greater detail in Appendix A. Of note is the 17% of the soldiers who registered with CCEP and did not report any Gulf-specific exposures but nevertheless have a record in the DMDC activation file, indicating that they were present in the Gulf. Thus, by the CCEP administrator's approach these soldiers would be considered non-deployed (in direct contradiction to their status as recorded in the DMDC activation files). Moreover, 8% of active duty Army soldiers who were on duty during the war and who responded to the CCEP items (indicating, according to the CCEP administrators, that they had deployed to the Gulf) did not match to the DMDC Gulf War activation records. The net effect is ambiguity in the measure that would have been most useful in establishing exposure or presence in the Gulf Theater and continued uneasiness on our part about the validity of both the CCEP and the DMDC activation measures documenting deployment.

We are concerned also about the potential for bias surrounding the use of certain data sources (in particular, inpatient hospitalization data) in the investigation of GW related health outcomes. Other authors have discussed some sources of bias but to our knowledge no one has conducted a single, systematic review of such biases and how they influence the use and interpretation of these data. We have initiated (and nearly completed) a manuscript reviewing what hospitalization data reveal about the health of GWE veterans and identifying the strengths and weaknesses of relying upon such data (see Appendix B, "Caveat Emptor: A three-decade view of hospitalization rates for conditions common among U.S. soldiers deployed to the Persian Gulf War: biases and challenges in interpretation"). Many of the findings in this paper are relevant to other sources of health data and should be considered before interpreting the results of any study focusing on the health of GWE veterans (more details regarding these efforts are described below under SOW C.1). Evaluation and validation of data is perhaps the least

glamorous aspect of epidemiological research, yet it is fundamental to the development of reliable and valid research models as well as the design of successful interventions and policy planning.

Though some aspects of our work have been discouraging there were many positive aspects as well. We have demonstrated that the TAIHOD is a relatively easy tool to use. We have linked files fairly quickly and easily with very little upfront cost. We have perfected our ability to manage and analyze large quantities of information on large cohorts of people in a short amount of time. Duplication of some data sources offers a unique opportunity for validation and evaluation of the various sources of information contained within the TAIHOD. Another key strength of the TAIHOD is its dynamic nature. While it already provides a massive and rich amount of information on all Army soldiers, it is continually being updated and expanded through the addition of new databases, all linked at the individual soldier level. For example, we are currently in the process of adding data on family violence. This will considerably enhance our ability to identify associations between redeployment and increased rates of domestic violence as well as potential modifying factors. We are also in the process of obtaining and adding the DMDC Worldwide surveys of active duty servicemembers. These surveys were offered to a sample of all Army servicemembers conducted in 1985, 1992, and 1999 statistically weighted to be representative of the entire Army population. Three thousand four hundred seventy-nine soldiers took the surveys in 1985, remained on active duty and ultimately deployed to the Persian Gulf. Information gathered in these surveys provide in depth information about respondent job satisfaction, job stress, job control, and overall satisfaction with occupation and personal life. Because this survey is administered through a population-based, statistically-weighted sampling scheme it is expected to provide good, generalizable data about soldiers in the Army at large. In addition, since it has been offered three times over the past 15 years some soldiers have taken it more than once. In fact, in addition to the usual statistical Army sample in 1992, all soldiers who took the survey in 1985 and were still on active duty in 1992 were re-surveyed. Therefore multiple measures for 1,342 soldiers are available, allowing us the opportunity to explore changes in responses that may occur between these two survey periods and the impact of changes in responses over time on soldier health.

The TAIHOD has great potential as a research tool for the study of deployment health. Though it contains relatively few HRAs in the period preceding Operations Desert Shield/Desert Storm, there are many more that were taken after the Gulf War. Among the 498,200 soldiers on active duty between June 1991, and December 1998, we have more than 393,122 validated HRA survey responses that have been positively linked to an active-duty soldier's record. Between 1990 and 1999 there were 45 Army deployments in addition to Operations Desert Shield/Desert Storm (1). This suggests that there are additional opportunities to investigate risk factors for health outcomes associated with deployment than were present with the cohort of GWE veterans. Our research team is continually searching for innovative and cost-effective approaches to study deployment related health concerns, and we are developing a proposal for a study that will leverage the strengths of the TAIHOD in a large-scale population based study of deployment health, focusing particularly on non-battle injuries that occur during and after deployments (including humanitarian and peacekeeping missions as well as combat missions). Because the TAIHOD was originally developed as a tool primarily for the study of injuries, it is uniquely suited to this purpose. Several studies have now indicated that non-battle injury has a greater impact on the health of GWE veterans (in terms of morbidity) than the ill-defined symptom-based conditions such as those commonly reported by participants in the veterans' registries.

Progress on specific SOW Objectives

The limited number of prewar HRAs has prompted us to revise our SOW objectives by refining activities where these surveys were to have provided key information for the models to be tested. We also propose expanding our objectives, through a grant application now in process, to include a more in-depth study of injuries and to extend our investigation of hospitalization rates for symptom-based conditions to include hospitalizations for deployment-related conditions in the years immediately following the Vietnam War.

Though this report covers research efforts related to the second year of our grant, the proposed changes to the SOW objectives being filed in our new grant application make it necessary to also include a discussion of SOW objectives from the first year. Many of the SOW objectives span more than one

year, and the products and efforts we have undertaken thus far often apply to and accomplish the objectives for multiple SOW objectives.

SOW Objectives for the First Year

Progress Goal C.1

Under this objective we were to measure the crude prevalence rate over the past 18 years among active duty Army soldiers (using hospitalization rates per month) for conditions most often reported by deployed GW veterans evaluated under the CCEP. We were to assess whether there is a significant change in rates of admissions immediately subsequent to the Gulf War (and whether the rates then return back to their baseline level), and identify any other points over past 18 years when rates have peaked. One manuscript was promised related to this SOW objective.

We have completed a draft of this manuscript. It has taken longer than originally planned for several reasons. First, we were able to obtain electronic records for inpatient hospitalizations from 1970-1980, which offered the opportunity to significantly expand (by over 50%) the time period covered by the trendline with the potential for uncovering important links between the experience of illness and deployments *per se*. It also, however, increased the complexity of the analysis. Between 1970 and 1998 the Army utilized 3 different ICD-based coding systems. Each switch to a new system resulted in changes in the way conditions were coded, often resulting in many more refined options for coding a condition that previously could only be coded in one, broad group. We have consulted with Ms. Donna Pickett at the National Center for Health Statistics and have also recently hired a trained and highly experienced nosologist to assist us in properly translating codes back to earlier time periods in order to compare trends across time periods for the same condition. Another related complexity is the apparent use of invalid ICD codes for some of the conditions reported by soldiers in the CCEP registry. Again, our interactions with Ms. Pickett, as well as numerous discussions with current and former managers of the CCEP database have been helpful in clarifying these issues and constructing a unified trendline of deployment related conditions for the entire period from 1970 through 1998.

Administrative changes in the management of patients and diagnoses of symptom-based conditions have also posed a challenge to the construction of a single coherent trendline. For example, in the 1970s it was not uncommon for young enlisted soldiers who normally resided in the barracks to be hospitalized even for relatively minor conditions in order to provide custodial care. It was also common practice to create a hospitalization record for an individual who was assigned to quarters but who never was actually admitted to the hospital. Similarly, many clinic cases were given hospital records even though they were actually outpatient visits. Appendix C depicts the influence of these cases if they are not excluded from the database. We have applied the same rigorous data cleaning methods to this issue as we have to the rest of the database, and believe we have isolated "true" hospitalizations.

In addition to documenting trends in hospitalizations for the symptom-based conditions common among deployed veterans, we have described some of our other efforts spent testing and validating data commonly used in the study of Gulf War Illnesses. A copy of this manuscript is in Appendix B. As it is under review it is considered proprietary and requires restricted public access.

Progress Goal C.2

Under this SOW we were to identify associations between individual characteristics (e.g., gender, age, race, occupation, rank), job performance indicators, and life stressors and subsequent development of Gulf War Illnesses. Under this effort our study team initially spent a great deal of time discussing how best to define GWI. As a team we developed a measure that focused on hospitalizations for ill-defined, symptom-based conditions (based in part on the findings of Roy et al. and the CDC (2, 3)). However, some of our early analyses using this definition of GWI (e.g., looking at deployed/non-deployed immediately after the war) suggested it did not discriminate well between deployed and non-deployed soldiers (in fact, non-deployed veterans appeared to be at greater risk for hospitalization from conditions found under this definition). After a great deal of debate we finally decided to include conditions most prevalent among CCEP registrants with a diagnosis other than healthy. While this list of diagnoses derive

from a self-selected population, the conditions do represent those of veterans who are most concerned about their health, and the resulting list of conditions as applied to hospitalizations seem to discriminate between deployed and non-deployed veterans in the population of GWE veterans at large (including veterans who did not register with the CCEP program).

We have also begun the task of creating variables that are markers for life stressors and job performance problems and developing the analytic model for this paper. The basic hypothesis for this paper is that the conditions GW veterans commonly experience (i.e., ill-defined, symptom-based conditions) may be explained, in large part, by individual factors and situational stressors. Thus, even soldiers who are not deployed but who experience these stressors might be at greater risk for these conditions. The goal of this paper is to see if we can capture important markers for stressors or stress susceptibility and thus predict who is most likely to experience a hospitalization for a Gulf War Illness, using the TAIHOD database.

Using a prospective cohort study design we will follow 641,639 GWE veterans (deployed and non-deployed soldiers) from June 1991, through June 1994, (i.e., three years after the war). Eligible subjects must be on active duty from December 1989, through June 1991. We will use standard time-to-event statistical modeling techniques (e.g., Kaplan Meier curves, Cox proportional hazard models). This will allow us to control for varying amounts of follow-up time among individuals as they leave the service during the follow-up period.

Risk factors will include:

Individual Factors (as of June 1990):

Age; gender; race/ethnicity; rank; educational attainment; time in service; marital status; duty status and location of spouse (not married, married--spouse not on active duty, married--spouse on active duty but not deployed to Gulf, married--spouse on active duty AND deployed to Gulf); number of dependents; ASVAB score (a measure of general aptitude or intelligence—we may have difficulty using these since they changed coding practices and scales and it may not be possible to determine the scale under which a given score was derived); and any PCS that occurred in the 6-month period prior to the war.

Life/Personal Stress Measures:

This variable will capture information on stressors, in particular changes that occur prior to and throughout the war, that might create or increase distress. These will be measured in December 1989, June 1990, December 1990, and June 1991. For example, we will calculate the number of changes in marital status, number of changes in the number of recorded dependents, and an interaction between these two variables.

Job Factors/Stress Measures:

We are constructing a variable that captures deviation from mean time in service for a given rank, with the expectation that those who have been at that rank and been in the service for a long time are not moving up as fast as their peers, possibly reflecting a performance deficit. This variable will also capture newly promoted soldiers (at a given rank for very short period of time given total time in service) who might be at increased risk. Thus this variable may have a bi-modal distribution with respect to GWI. Because some occupations do not afford the same opportunities for promotion final analyses will account for this potential bias. We will also explore the potential role of working (duty MOS) in the job for which a soldier was perhaps not trained (primary MOS).

Prior Health Status:

We will look at the period between December 1989, and August 1990, for any hospitalization, and for hospitalizations for GWI conditions.

We have completed the creation of the dataset and variables for analysis and have completed some of the descriptive analytic steps. Because this effort is somewhat exploratory we have also elected to pilot test another analytic approach simultaneously. We are evaluating the use of the SAS Enterprise Miner tool to see if this approach yields similar findings to our more conventional approach or if it highlights new hypotheses. We expect both of these efforts to be completed this fall and to result in one or two manuscripts.

Preliminary findings from these analyses demonstrate that soldiers who experienced multiple changes to their marital status and number of dependents between December 1989 and June 1991 appear to be at greater risk for a subsequent GWI hospitalization. More details of these early efforts are reported in Appendix D.

Progress Goal C.3

Under this task we were to focus on the sub-populations of Army soldiers who have taken an HRA to see if the inclusion of measures of stress, distress, and health habits from the HRA improves our ability to predict development of Gulf War Illnesses (i.e., add these items to the model described under C.2 above)

It was not possible to complete this task due to too few prewar HRAs that could be clearly confirmed as belonging to a unique individual on active duty in the Army. There was no paper promised under this SOW objective. We are in the process of requesting permission to remove this objective from our SOW. We are also developing a technical report which will describe the Army's HRA, sources of items, strengths, limits, and methods of administration. This information should be useful to other investigators who seek to utilize the rich data contained in the HRA survey data but who may as yet be unaware of the limits and challenges to its use.

Progress Goal C.4

Under this task we were to compare the prior health, job, and personal attributes of active duty soldiers who were deployed to the Gulf to those who are on active duty but not deployed to the Gulf, in order to determine whether or not those who are deployed take greater risks than those not deployed or are inherently at greater risk for postwar illnesses because of some pre-existing prewar factors.

This task was completed and though no manuscript was required to meet the SOW objective, we have a manuscript reporting our findings in press at the journal *Military Medicine* (see Appendix E).

SOW Objectives for the Second Year

Progress Goal C.5

This objective indicated that we would add a variable indicating deployment status to the Gulf to the models that were to be developed in year one (under SOW C.2 and C.3). The key research question to be addressed by this analysis is, "does deployment significantly improve prediction of subsequent development of Gulf War Syndrome?" No manuscripts or reports were planned related to this objective.

Because it was not possible to complete task C.3 (due to too few prewar HRAs), it is also not possible to complete C.5. We are submitting a request for a revision to our existing SOW to drop the portion of this SOW that uses prewar HRA variables. However, in developing the paper described above under C.2, we will also test for the influence of adding deployment status to the model. This will accomplish the basic goal of the C.5 SOW objective: that is, determine whether deployment status influences or predicts propensity to develop GWI.

Progress Goals C.6 and C.7

Under this objective, we plan to assess the impact of stressors that occur during the war and their association with the subsequent development of Gulf War Illnesses among deployed soldiers. We will develop a number of measures/proxies for exposures to stressors during the war, such as dates of deployment to the Gulf that indicate the phase of the conflict during which the soldier was deployed, duration of deployment, and the influence of being a dual military couple—particularly if a spouse is also deployed to the Gulf. This effort also originally called for the use of prewar HRAs, as well as other data sources, to identify potentially important risk factors for postwar illness. We are asking to delete that portion of this SOW objective, but still intend to complete the remainder of this task. We will develop a model that includes only deployed veterans and examine individual and war-related factors that may help

explain variation in who ultimately got sick and who did not. We initially operationalized phase of deployment in three distinct stages: time spent in theater during the early (pre-hostile fire) phase, versus the middle (hostile fire) phase, versus late (post cease-fire) phase, with the expectation that presence in theater at these three different stages may influence the subsequent health of deployed servicemembers differently. At a recent conference on operational stress and health, however, it became clear to us that there is another, very late phase that may also be important. After most soldiers had been re-deployed a small group was left behind. Some of the presenters at the conference indicated that it is often highly stressful to remain in a deployed setting (whether in a peacekeeping or combat related mission) when the majority of the force has been redeployed. On the other hand, there were also soldiers who did not participate in the first three phases of the Gulf War but who volunteered to go after the cease-fire. Thus, it seems that those present during the very late phase of the conflict (i.e., after June 1991) may have experienced very different stressors than those who were present at any or all of the three earlier stages. We expect to begin developing the dataset and variables for this effort in August 2000. Though no paper was planned for this objective we expect to complete a manuscript late in CY 2000.

Progress Goal C.8, C.9, and C.10

These SOW objectives focused on active duty Army soldiers who took the HRA both before deployment and after December 31, 1994, in order to assess changes in self-reported levels of stress, distress, and health risk behaviors. A paper was promised related to these objectives but cannot be completed. There were not many confirmed prewar HRAs and an even smaller subset of soldiers who took an HRA both before and after the war. We are requesting a revision to our current SOW that removes this requirement.

Under SOW C.10 we were to assess the impact of work, family, etc., as effect modifiers on risk of GWI and to identify important modifiers of the association between stressors, distress, functional status, health behaviors, and the development of health problems. Though we cannot use the HRA we are, nonetheless, including other measures of life stress in our current endeavors (see C.2 and C.5). We will also include potential effect modifiers in these analytic efforts that will address the intent of this SOW (C.10) objective.

SOW/TIMELINE 21-24

This was not a specific SOW objective but was included on the timeline of milestones and major products. Under timeline 21-24 we indicated we would write a report describing the utility of TAIHOD as a tool for the study of deployment/war-related conditions.

We have begun this process and will produce several reports to detail our findings. One report, mentioned earlier, describes the history of the Army HRA, sources of the items contained in it, and validation of these items. A second report documents the generalizability of responses to the HRA items based on the populations who took the HRA, distribution of responses, and missing or extreme (atypical or "outlier") responses to key items. After the remaining three manuscripts (and related analyses) are completed we will also write a technical note that discusses the TAIHOD specifically as a tool for the study of deployment and health related conditions.

Other Findings

A final manuscript (currently under review at the journal *Injury Prevention*) highlights the importance of adding the study of injuries to the deployment health research agenda us (see Appendix F). We believe the TAIHOD may be particularly well suited as a tool for the study of war-related and post-deployment non-battle injuries, since it was originally developed specifically to study injuries and because we have continued to add data that will allow us to investigate a rich and varied host of potential risk factors (e.g., other deployments, occupational stressors or problems, personal risk factors, AEDR data on aviators, and health risk behaviors) as well as health outcomes (e.g., outpatient visits, experiences of family violence). In addition, much of our research teams prior experience and training has been in the field of injury epidemiology. Since injuries are currently the only documented source of increased mortality among deployed GW and Vietnam veterans (4-14), the TAIHOD and our research team are

uniquely poised to conduct analyses to identify important risk factors and effect modifiers and to clarify the types of injury outcomes that are more likely to affect deployed veterans. This renewed attention to deployment and non-battle injuries is the focus of a request for continuation funding currently under review.

7. Key Research Accomplishments

- Extended analysis of hospitalization rates for Gulf War-prevalent conditions to include entire period from the 1970 through 1998.
- Investigated and reported results from study of threats to validity and sources of bias in the use of hospitalization data for the study of Gulf War illnesses.
- Identified measures of stressors using existing data (in lieu of HRA measures) and tested utility of these measures in explaining variation in hospitalizations for Gulf War illnesses.
- Found evidence suggesting that life stressors, such as changes in marital status and number of dependents, are associated to GWI.
- Also found evidence suggesting that time-in-service for soldiers of a given rank, as compared to peers of the same rank, may be related to GWI where those in that rank for the shortest and the longest durations are at greatest risk of GWI; those in that rank for an average amount of time are at lowest risk.
- Compared CCEP to DMDC records for activation to the Gulf War theater of operations and demonstrated inconsistencies. Also discovered administrative decision made regarding the CCEP data that had a profound effect on our ability to evaluate these data for quality and completeness.
- Refined analytic model and completed a manuscript outlining hypothesized pathways to explain the association between deployment and injury.
- Initiated process for obtaining new data on occupational satisfaction, stress, and related factors that may also influence risk for Gulf War illnesses
- Initiated process for obtaining new data on important health outcomes (family violence data from Army Central Registry, Aviation Epidemiology Data Registry (AEDR), linkage to Veteran's Administration in-patient, outpatient and death records).
- Documented characteristics of those who completed an HRA and those who did not. Noted demographic associations with patterns of missing responses to key items (e.g., indicators of alcohol misuse or abuse).
- Continued efforts to document the history of the creation and administration of the Army's Health Promotion program, including a comprehensive summary of the survey items on the Health Risk Appraisal Fit to Win questionnaire.
- Documented that studies of GWI that utilize data on inpatient hospitalizations alone will provide a skewed picture of the health of GWE veterans; specifically, such studies capture only the experiences of the most severely ill soldiers, and, because certain conditions common among veterans are more likely to be seen on an outpatient basis, hospitalization data for some types of conditions prevalent among GWE veterans will provide only a very limited view of the total morbidity experienced by GWE veterans.
- Determined that external events, including comprehensive efforts to downsize and realign military bases, and extensive media coverage of several high-profile sexual misconduct cases in the military, occurred at around the same time as certain peaks in the hospitalization rates of many conditions commonly reported by GWE veterans. Because these events seem likely to be stressful for active duty soldiers it makes it extremely difficult to parse out the influence of war-related experiences from these external events on the health and well-being of GWE veterans.
- Discovered evidence of a healthy warrior effect among GWE veterans; in that even though the percentage of soldiers who seek care from the VA Persian Gulf Registry after the war without having registered with the CCEP is small, there are large numbers of soldiers who ultimately seek care for Gulf War deployment related health concerns in the Veteran's Administration system but who did not register with the CCEP while on active duty.

8. Reportable Outcomes

Manuscripts

- Demographic, physical, and mental health factors associated with deployment of US Army soldiers to the Persian Gulf (In press, *Military Medicine*; Appendix E)
- Commentary: Excess injury morbidity among veterans of the Persian Gulf War: a model of proposed etiologic pathways (Under review, *Injury Prevention*; Appendix F)
- Caveat Emptor: A three-decade view of hospitalization rates for conditions common among U.S. soldiers deployed to the Persian Gulf War: biases and challenges in interpretation (Appendix B).

Progress Toward Academic Degrees

Two students are directly supported on a part-time basis by funds from this grant.

- Mr. Jeffrey Williams is working towards completion of his master of science degree in epidemiology at University of Massachusetts Amherst.
- Ms. Laura Senier completed her master of public health degree from Boston University in May 2000.

Other Education and Training Programs

Three members of our team have received special training in innovative database management techniques and data presentation approaches.

- Dr. Amoroso and Mr. White attended a course run by SAS Institute (Cary, NC) entitled SAS Enterprise Miner: Applying Data Mining Techniques. This course has aided the research team in designing a data warehouse to use in researching the relationship between life stressors, demographic characteristics, and deployment information and the development of a Gulf War Prevalent Illness.
- Dr. Amoroso and Mr. White attended a course run by SAS Institute (Cary, NC) entitled Building a Data Warehouse Using SAS Warehouse Administrator Software. This course has aided the research team in understanding and applying data mining techniques to apply in researching the relationship between life stressors, demographic, and deployment information and the development of a Gulf War Prevalent Illness
- Ms. Senier and Mr. White attended Edward Tufte's one-day course in Presenting Data and Information in Boston, Massachusetts. This course has aided the research team in designing clear and easily interpreted figures to display the combinations of trends in hospitalization rates and other simultaneously occurring events in the research period under study.

9. Conclusions

- HRA data needs to be carefully evaluated and validated before researchers can rely on them. We strongly encourage anyone who acquires these data or intends to use them from a source other than the TAIHOD to contact our research team for advice on how best to proceed.
- Hospitalizations are likely to miss cases for some types of condition. For example, musculoskeletal conditions may be particularly likely to only receive care in an ambulatory setting. On the other hand, mental disorders may be more likely to be captured in hospitalization data.
- Prior studies relying on hospitalizations, particularly where trends are noted, should be interpreted with caution as there were several administrative practices and coding changes that affected hospitalization rates over time. Researchers interested in evaluating temporal trends in hospitalizations should consider contacting our research team for information regarding potential pitfalls and challenges.
- Managers of large military databases, such as the CCEP, should be given more explicit instructions about the importance of maintaining complete records. There should be more involvement of data users (researchers, policy makers, medical care providers) in the construction and maintenance of these systems.
- Resources should be devoted immediately to the evaluation of the Gulf War activation records. This crucial piece of information about possible exposure needs to be better understood both because of its widespread use in studies already completed and to avoid repeating mistakes in future deployment-tracking efforts.
- Stressors in a soldier's personal life or on the job increase risk for illness hospitalizations. These experiences may interact with war-related or deployment-related stressors to further exacerbate risk for a GWI.
- Injury persists as the only documented source of excess mortality among Gulf War veterans. Excess injuries were also documented among U.S. and Australian Vietnam veterans. More research is needed to clarify the link between deployment and injury: to document a link and to clarify which of the potential causal pathways is/are operating to increase risk; and to identify important risk factors or modifying factors that might reduce injury risk or adverse sequelae.

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11. Appendixes

NOTE: These Appendixes contain proprietary information (research results underway or not yet reported) and drafts of manuscripts still in press or under review.

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Appendix A. Results of efforts to validate Gulf War activation file

To begin evaluating accuracy of the information in the Gulf War activation files, we compared the deployment status of soldiers who served in the Gulf (as indicated by the DMDC Gulf War activation files) to responses to certain items on the CCEP questionnaire, looking for consistency and inconsistencies between these two sources of information. There are three Gulf War activation files, which comprise the years 1990-1994, and report deployment status information on all service members. Registrants in the CCEP subsequently received medical evaluations, were asked questions about service in the Gulf and exposure to various agents that have been implicated in the development of Gulf War Illness. Question 122 explicitly asked respondents to respond with either a yes or no response to the statement, "I served in the Gulf War." Negative responses to this question might appropriately come from several different groups of individuals: soldiers who were deployed to the region after cessation of hostile fire, soldiers who believed they had illnesses related to the war though they were never actually in theater, and spouses or other family members evaluated for health complaints they believed to be related to their sponsor's service in the Gulf. Questions 123-151 were intended to query persons who had actually been in the Gulf as to their exposure to various agents that have been suggested as etiologic factors in the development of Gulf War Illnesses (e.g., smoke from oil well fires, vaccines and prophylactic agents, chemical warfare agents). The survey instructions directed respondents to skip questions 123-151 if they had answered no to question 122; if they had answered yes to question 122, they were supposed to have answered all of questions 123-151.

While these two data sources show initial promise as tools to assess convergent validity, their utility for this purpose is crippled by an administrative decision surrounding the management of responses to the CCEP survey. Specifically, question 122 was deliberately deleted or omitted from the electronic database. The CCEP database administrators believed that the answer to this question could be inferred from the answers to questions 123-151 and, in the interest of efficiency, deleted it from the electronic file. That is, if a respondent had not been in the Gulf, they would not have answered any of these questions, and would presumably have answered no to question 122 as well; conversely, if they responded to any of these questions, they presumably would have answered yes on question 122. However, as might be expected from survey data, our early reviews suggest that in fact many of the questions about Gulf-specific exposures were actually answered by persons who were not deployed (e.g., family members and non-deployed soldiers).

The CCEP registry at the time we evaluated it contained a total of 50,604 records, 48,315 of whom were given the CCEP survey. Overall, 37,554 of the people who were ever deployed to the Gulf (i.e., could be found in one of the three DMDC Gulf War activation files) registered with the CCEP. Conversely, 78% of those with CCEP records could be found in one of the Gulf War activation files. Table A1 shows that of the 37,554 soldiers who appear in the Gulf War activation files AND responded to the CCEP, almost one-fifth did not answer any of the items on the survey pertaining to exposure (items 123-151). Under the CCEP administrator's definition, these people should not have been in the activation file, since a response to these items is the criterion they propose for ascertaining deployment status.

Table A1. CCEP survey responses indicating non-participation in Gulf War vs. DMDC Gulf War Activation file

GW Activation File	Total # of Records Matching the CCEP	Answered any question 123-151	Did Not answer any question 123-151
Deployed 1990-1991 (n=271,654)	33,127	27,338 (83%)	5,789 (17%)
Deployed 1991-1993 (n=38,446)	3,514	2,877 (82%)	637 (18%)
Deployed 1994 (n=13,504)	913	753 (82%)	160 (18%)

There are inconsistencies when we compare in the opposite direction: examining CCEP respondents who completed any of the items (123-151), which should indicate their presence in the Gulf, to the DMDC Gulf War activation list. We took all CCEP survey respondents who indicated they were on active duty in the Army during the Persian Gulf War (n = 33,884) and who completed at least one of the

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items indicative of exposure to the Gulf (n = 27,999). These were then matched to the DMDC Gulf War activation file. Eight percent (n=2,247) did not match, though by the CCEP administrator's definition this group should have been included in the DMDC activation files.

Clearly there are important discrepancies that deserve further investigation. It is important to clarify the quality of these data not only to facilitate our interpretation of findings that have relied on this source of deployment information but also to improve our management of records during and after future deployments.

Appendix B. Caveat Emptor: A three-decade view of hospitalization rates for conditions common among U.S. soldiers deployed to the Persian Gulf War: biases and challenges in interpretation

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Introduction

The United States deployed nearly 700,000 soldiers to the Persian Gulf in support of Operations Desert Shield/Desert Storm, in the largest military operation it had undertaken since World War II. Not long after these soldiers began returning to the United States, reports of unexplained illnesses began to surface, and many soldiers associated these illnesses with their service in the Gulf. The U.S. government has invested nearly ten years of intensive research and more than one billion dollars, but scientists and physicians have not yet been able to solve completely the mystery of Gulf War Illness.

The search for an explanation for the health problems experienced by Gulf War veterans is hampered by the fact that there is still no agreed-upon case definition; that is, physicians have not been able to detect a single organic disease that is responsible for triggering the diverse symptoms and illnesses common among these veterans. In fact, many of the symptoms that are troubling these veterans are characteristic of more than one disease (e.g., sleep disturbances are associated with sleep apnea, depression, and fibromyalgia). Many different etiologies have been suggested, including exposure to chemical and biological warfare agents, depleted uranium, smoke from oil well fires, pesticides and insect repellants, reactions to prophylactic agents (such as pyridostigmine bromide or vaccines), infectious diseases, and psychological stressors. Finally, it has been noted that veterans of many other conflicts (dating back even as far as the American Civil War) have similarly complained of symptoms and ill-defined medical conditions subsequent to military service, and that perhaps it is not deployment to the Persian Gulf *per se* that is causing the health problems of Gulf War veterans, but deployment to a wartime environment.

Efforts to document, describe, and determine the causes of Gulf War Illnesses have employed a variety of methodologies, including the use of data from veterans' health registries, interviews and examinations of small groups of veterans from a particular unit or geographic area, and the review of hospitalization and mortality records. While data from veteran registries and small group interviews often suffer from potential self-selection bias and may be of limited generalizability, the use of hospitalization and mortality records is also fraught with biases that may affect their usefulness and interpretation. The purpose of this paper is to review what hospitalization records demonstrate about the health of Gulf War veterans,

identify the strengths and weaknesses of using these data, and review biases that may impact the interpretation of these data.

Background

Research into health consequences of Gulf War Illness has concentrated principally on the myriad of symptoms, signs, and ill-defined conditions that afflict many veterans, and on more serious health consequences, such as mortality, hospitalizations, and birth defects, which may often be studied more objectively and comprehensively. A review of death certificate data showed that death rates among deployed veterans are similar to those among non-deployed veterans for all conditions except accidental deaths (such as motor vehicle accidents). Mortality is still a rarely uncommon outcome, however, as would be expected, since the population of soldiers deployed to the Gulf were young and healthy.

Hospitalization data often provide the greatest depth and breadth of information in a format useful for population-based studies. They are readily available in electronic format, contain information on a large population of active-duty soldiers, are fairly complete with relatively little loss to follow up, and in many cases, provide some of the only information about morbidity available for the total population of deployed and non-deployed Gulf War Era (GWE) veterans both before and after the conflict. A review of hospitalization data on GWE veterans showed that>> to be added <<.

Hospitalization data are not, however, without limitations. There are at least five potential limits to the use and interpretation of hospitalization data to describe the health experiences of GWE veterans.

1. Temporal changes in hospital admission and coding practices.

Given that veterans of other conflicts have also experienced health problems subsequent to deployment, it is difficult to ascertain whether the health experiences of GWE veterans are similar to or different from the experiences of veterans of other conflicts. In fact, many of the symptoms common among GWE

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veterans are commonly found in any large population (cite studies of back pain, etc., among primary care patients here), and it has been hypothesized that the rates of these conditions found among deployed soldiers do not, in fact, represent an increase in these conditions after the war, but are just a documentation of what might be considered the background rate of these symptoms. A review of trends in hospital admissions for these conditions over time, however, is hampered by changes in hospital admission practices and coding systems. For example, while we may be inclined to look for increases in hospitalizations for common post-deployment health conditions subsequent to the Vietnam War and compare them to hospitalizations for similar conditions subsequent to the Gulf War, there are several forces at work that would bias such an analysis. First, over the past twenty or thirty years there have been improvements in medical care and cost containment pressures that have been exerted by a system of managed care; these factors have resulted in more patients being seen on an outpatient basis, and fewer inpatient hospitalizations. Second, there have been periodic changes in the ICD system of coding hospitalizations; the Army used ICDA8 from 1971 to 1979 then switched to ICD-9 from 1980 to 1985, and then switched again to ICD-9-CM in 1986. Any analysis of hospitalization trends over such a long period of time must carefully account for coding differences. Finally, the switch to DRG based coding of conditions in the military healthcare system may have affected the use of codes for conditions prevalent among GWE veterans.

2. The types of conditions common among GWE veterans are typically treated on an outpatient basis.

The symptoms that plague many GWE veterans, while they may be painful and debilitating, are typically treated in outpatient settings such as clinics or physician's offices and rarely require hospitalization. Outpatient data are not available in electronic form until 1997, making it impossible to study outpatient conditions among GWE veterans occurring immediately after the Gulf War. It is unfortunate that outpatient data from the early 1990s are not available in electronic format, as they would be a useful complement to the study of hospitalization records among these veterans. It is possible that the soldiers who were ultimately hospitalized are not truly representative of the general population of GWE veterans. If the only cases that resulted in hospitalization were those that were most severe, then using

hospitalizations as proxy measure might result in a realistic picture of the overall morbidity of GWE veterans. If, on the other hand, some conditions were more likely to result in hospitalization regardless of severity, then the resulting picture of morbidity among GWE veterans is likely to be skewed, making it difficult to understand and describe risk factors accurately, especially for those conditions that, even when severe, were less likely to result in hospitalization. Most troubling is the possibility that certain conditions were more likely to result in hospitalization based on a soldier's deployment status, branch of service, or duty status (e.g., active duty, Guard, or Reserve). If this were proven to be the case, then it would be nearly impossible to link deployment-related morbidity to basic demographic characteristics, preventing a meaningful assessment of risk factor identification.

3. Healthy warrior effect bias.

Because health records for soldiers on active duty are maintained separately from those who have been discharged and are seeking care through the Veterans Administration (VA), the studies that have been done to date capture only the experiences of soldiers who are either still on active duty OR who have been discharged. Many hospitalization studies have focused only on those soldiers who remain on active duty, leaving the significant probability of a healthy worker or "healthy warrior." Other Gulf War health researchers have recognized this limitation. Gray et al. recently attempted to link data on hospitalizations among active duty servicemembers with hospitalization data from the VA and with discharge information from California hospitals in order to better track the health of servicemembers during and after they leave active duty [Gray, 2000 #45]. They were not, however, able to identify unique individuals and thus the issue of following discharged soldiers remains. Similarly, the data sources currently available are inadequate to describe accurately the health experiences of soldiers in the National Guard or Reserve, or for detecting diseases with long latency periods, as soldiers are lost to follow up after discharge.

4. DoD/Army policies related to the evaluation and management of Gulf War veterans health.

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The Department of Defense (DoD) instituted specific administrative responses to the concerns regarding illnesses among GWE veterans, which may in turn have influenced hospitalization rates. In June of 1994, the DoD formed the Comprehensive Clinical Evaluation Program (CCEP) to evaluate the health of soldiers who served in the Gulf [Joseph, 1997 #8]. By 1996, approximately 100,000 of the 700,000 soldiers who had served in the Persian Gulf War had registered with CCEP for evaluation of health complaints that they believed were related to their service in the Gulf [Haley, 1997 #9]. The VA instituted a similar health registry in MONTH YEAR to evaluate the health of veterans who were no longer on active duty. Under the CCEP, soldiers are referred first to a local medical treatment facility for a Phase I evaluation by a physician; if they and the doctor are concerned about the outcome of this evaluation, the soldier may be referred on to one of 14 regional centers for a more intensive Phase II workup. Concern for soldiers' health may have led to lower thresholds for admitting deployed veterans for workup of conditions that might normally have been seen on an outpatient basis only. This may have resulted in a spurious increase in hospital admissions among deployed veterans. On the other hand, it is also possible that deployed veterans received such thorough workups during CCEP Phase I evaluations that they were less likely to be hospitalized for more thorough workups than their deployed counterparts.

Additionally the creation of these health registries may have provided veterans suffering from conditions that were *not* caused by deployment to attribute their symptoms to the war nonetheless. That is, the war or related experiences may have provided a "focalizing point" for the soldier suffering from various conditions (reference others who've also suggested this—see Barsky and Borus, 2000—ask Chuck for other suggestions for references). Also, soldiers who were veterans of the Gulf War might be particularly likely to seek care or evaluation for the condition if they believe health or other financial benefits might become available to them (references—others have said something like this).

Finally, there is lingering concern over whether U.S. troops were exposed to chemical weapons during the war. Although the DoD insists that there is no evidence to support a contention that Iraq used chemical weapons against U.S. troops during the war, in the days after the cease-fire, U.S. troops destroyed an Iraqi weapons bunker at Khamisiyah that was later found to contain rockets carrying the

nerve agents sarin and cyclosarin. Although no soldiers demonstrated any acute health effects immediately after the bunker was destroyed, there is uncertainty as to whether brief exposure to low levels of these agents may cause health problems. In October of 1996, the DoD sent letters to approximately 20,000 soldiers who were within 50 kilometers of the Khamisiyah bunker when the demolition occurred, notifying them that they may have been exposed, asking for their assistance in the ongoing investigation, and encouraging them to seek a health evaluation if they were experiencing any health problems [Rostker, 2000 #46]. In January of 1997, these soldiers received survey questionnaires to collect pertinent data regarding their experiences at Khamisiyah. [Approximately 30% of the soldiers returned completed questionnaires, and only approximately 30% of those responding indicated that they were eligible for health evaluations through the CCEP and VA health registry [, 1997 #47].] The DoD used the information gathered from the surveys and meteorological data to refine the estimates of which soldiers might have been exposed, and in July 1997, sent 97,837 letters to soldiers notifying them that they were probably exposed. In addition, 9,551 soldiers who had received letters in October of 1996 were sent new letters to tell them that, based on the revised information, they were not exposed to the fallout from the destruction of this bunker [Rostker, 2000 #46]. The belated disclosure of the presence of chemical warfare agents in the theater received a great deal of attention from Congress and the media. While the DoD fulfilled a clear obligation to provide information to those who might have been exposed, the chain of letters sent out might have raised more questions than they answered and may have augmented stress among those soldiers who received them. The media coverage of this event and the written correspondence sent out by the DoD might encourage a soldier who was experiencing symptoms to attribute them to the Gulf War.

5. Events external to the war may increase stress and possibly influence risk of illness among GWE veterans.

There is one final challenge in using hospital data that is nearly unique to this particular war, and that is the extent of media attention that has surrounded both the war and the subsequent search for causes of the mysterious "Gulf War Illness." Operation Desert Storm was a uniquely public war, and this intense

media coverage became focused on the health status of the returning veterans almost immediately after the conclusion of the conflict. In fact, not even a full year had elapsed before the first reports of a mysterious illness began to surface in the media. This media coverage undoubtedly compounded the stressors of war, as returning veterans began to wonder about how their service in the war might have impacted their health. An analysis of soldiers enrolling into one of the veterans' health registries found that the number of people calling the toll-free information line corresponded very closely to media coverage of Gulf War Syndrome [Gray, 1998 #42].

If stress may be a causal or contributing factor in the development of Gulf War Illnesses, as many have suggested, and if that stress may have been triggered or compounded by media coverage of the health problems of soldiers who served in the war, then it stands to reason that media coverage of other military matters may have elevated stress levels and influenced rates of illnesses among soldiers. Over the past 15 years, for example, the military went through a period of downsizing, with attendant coverage of the Congressional debates about which military bases were to be closed or realigned. It is conceivable that downsizing, or the threat of downsizing triggered by the media coverage of these events, may have increased risk of stress-related conditions among military. There have been numerous studies of downsizing in civilian workplaces that have linked the associated stressors with elevated rates of illnesses, both among those who were downsized and among those who retained their jobs, as they tried to adjust to increased workloads. (Moore, et al, 1996; Reissman, et al, 1999; Makowska, 1995; Schnall, et al, 1992; Kahaleh, et al, 1998; Jacobson, 1987; Fleming, et al, 1984; Ferrara-Love, 1998; Dew, 1992; Arnetz, et al, 1991; Ketter, 1994).

In addition to the controversies surrounding military downsizing, the military was plagued throughout the 1980s and 1990s by several high-profile cases of sexual misconduct. Studies in the civilian literature have shown that sexual harassment in the civilian workplace increases levels of stress among both men and women (Murdoch, Nichol, 1995; Bell, et al, 1998; Crull, 1982; Fontana, Rosenheck, 1998; Goldenhar, et al, 1998; Martin, 1992; Richman, et al, 1996 and 1999; Ritchie, 1998; Rondeau, 1992; Schneider, et al, 1997; Thacker, et al, 1996). The increased media and policy focus on appropriate conduct and sexual

harassment in the military may have increased job stress for some soldiers, and may be responsible for increased rates of some stress-related health problems.

While it may be reasonable to expect that stress and uncertainty surrounding downsizing or sexual misconduct might influence soldier health, it stands to reason that these stressors would affect the health of both deployed and non-deployed soldiers, and that we would see the trend in hospitalizations for stress-related health conditions change in conjunction with these events among both groups of soldiers. The question remains, however, whether these stressors, in conjunction with the stressors of the wartime theater, exerted a synergistic effect on the health of deployers, placing them at an even greater risk than that experienced by non-deployers. If such an interaction is taking place it would be nearly impossible to tease out the effects of stress related to military downsizing and appropriate sexual conduct from stress related to Gulf War deployment.

Methods

The Data

The Total Army Injury and Health Outcomes Database (TAIHOD) [Amoroso, 1997 #35][Amoroso, 1999 #43] was used to identify and describe the demographic and health characteristics of the study population. The TAIHOD links key elements from seven major Department of Defense (DoD) administrative and health databases using encrypted social security numbers. Components used for this study include personnel records from the Defense Manpower Data Center (DMDC) (including demographic data and Gulf War deployment status); hospitalization data from the Patient Administration Systems and Biostatistics Activities (PASBA) (including cause and nature of the condition); and data from the CCEP (including diagnostic results of the systematic clinical evaluations). The DMDC demographic data is reported twice a year, in June and December; the TAIHOD includes data from 1980 to 1998.

Outpatient data were not available in electronic format until 1997 in the TAIHOD. In addition, data acquisition and reporting to this system was not reliable in this first year. Thus we drew data on inpatient hospitalizations and outpatient visits for calendar year 1998 for Gulf War-revalent conditions so that we might better characterize the types of health contacts Gulf War era veterans were having with the health care system in total and to clarify the possible limits of using just hospitalizations to describe the health experiences of GWE veterans.

Study Population

To evaluate temporal trends in hospitalizations from 1970-1997 all active duty Army soldiers were included. For each time interval in which rates of hospitalizations were calculated the total number of soldiers on active duty in the end of the calendar year were used for the denominator.

For most other analyses where the main study group was GWE veterans, we defined the study cohort as soldiers who were on active duty at each of the 3 DMDC data points encompassing the Gulf War (June 1990, December 1990, and June 1991; N=675,626). We chose this group to control for differences in the exposure risk (i.e., potential for deployment), because being on active duty at all 3 of these points ensured that all members of the study cohort had the potential to be deployed to the Gulf during the war.

To evaluate the potential for a healthy worker/warrior effect we created 3 datasets to be linked to VA data. For this analysis, we drew information on all soldiers who were on active duty in the Army at any time between June 1990 and June 1991 (n=836,363). The datasets contained unique identifiers but no other distinguishing information. Each dataset corresponded to one of the following groups: Soldiers who had registered (while on active duty) with the CCEP as of June 1998 AND who had received a primary diagnoses of "healthy" (N=10,700); soldiers who had registered with the CCEP and received a diagnosis other than "healthy" (N=22,054); soldiers who did not register with the CCEP (N=803,609). We asked VA researchers to match these files to their records to identify soldiers who had registered with the VA

Persian Gulf Registry and then to show proportions of veterans who reported symptoms and who received a diagnosis other than healthy.

Variables for Analysis

Deployment status was identified as being sent to the theatre of operations at any time during the Persian Gulf War (August 1990-June 1991). The main outcome measure for these analyses was hospitalization for one of the 25 most commonly diagnosed ICD-9-CM conditions among soldiers who registered with the CCEP. For purposes of these analyses we used the primary diagnosis from the most comprehensive CCEP workup a soldier received. We then plotted rates of these conditions among all Army soldiers who were on active duty from 1970 through 1998. To control for changes between versions of the ICD codebook, we {IN PROCESS—STILL WORKING WITH NOSOLOGIST TO COMPLETE THIS TASK}. We also plotted rates of hospitalization for several non-discretionary conditions in order to evaluate the effect of administrative changes in hospitalization practices. Appendicitis (ICD codes 540-543.99) and fractured skull (ICD codes 800-804.99) were selected as non-discretionary comparison hospitalizations, since those conditions are typically severe enough to result in at least a one-day hospital stay, and would therefore be less susceptible to the cost-containment pressures that moved many conditions to outpatient care.

Media Search

To quantify the media coverage surrounding Gulf War Illness, military downsizing, and sexual misconduct in the military, we counted the number of newspaper articles concerning each topic. The number of newspaper articles appearing over the course of time would presumably illustrate both the magnitude of importance placed on an issue and the exposure of military personnel to information that is potentially stressful.

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We searched the Lexis-Nexis database of all major newspapers (list of papers not shown but available upon request from the authors), in all cases restricting the search to "major stories about this topic." We reviewed the full text of all articles that came up in response to the search terms as outlined below, and discarded any that were not relevant to the topic. Identical articles appearing in the same newspaper on the same day were discarded, although identical articles appearing in different newspapers were counted twice, on the assumption that such articles were probably picked up from one of the major news wire services and on the theory that they represented increases in exposure to media coverage of the topic at hand. [Identical articles appearing in different editions of a particular newspaper are counted individually, as each edition covers a different geographic region of the newspapers readership.]

To search for articles concerning military downsizing, we searched on combinations of the terms "base AND military" and "closing OR closure." To search for articles concerning sexual misconduct in the military, we searched for combinations of the terms "sexual" and "military." These searches were conducted and all stories reviewed from the period 1985 (five years before the Gulf War) through 1998 (the end of the study period). To search for articles concerning Gulf War Illnesses, we searched on the combinations of the terms "Gulf War" AND "illness OR syndrome OR sick OR injury." We searched for these articles from June 1991 (that is, immediately after all troops who participated in the ground war had been redeployed) through December 1997. As of December 1997, only 29% of the soldiers who had been deployed during Desert Storm remained on active duty.

Analytic Approach

Hospitalization rates for Figure 1 were calculated using the number of hospitalizations among active duty soldiers for the 25 most commonly diagnosed ICD-9-CM conditions in the CCEP or the number of hospitalizations for appendicitis as the numerator, divided by the number of people on active duty in each year.

Figure 2 rates were calculated using TAIHOD hospitalization and outpatient data to compare visits for any of the top 25 CCEP diagnoses. The denominator used was the number of soldiers on active duty in 1998. This analysis involved only the primary diagnosis. Multiple visits to health care providers for the same ICD-9-CM code were included.

Hospitalization rates for Figures 3 and 4 were calculated at 6-month intervals (June and December) by dividing the number of hospitalizations among the study population of GWE veterans by the number of GWE veterans on active duty in that same 6-month period. When calculating rates in any 6-month period, we counted only the first hospitalization for any of the conditions common among veterans in our analyses. Hospitalizations were further stratified by deployment status and place of hospitalization (i.e., one of the 14 regional CCEP centers or other military medical facilities).

Results

Table 1 details the conditions (other than "healthy") most commonly diagnosed among veterans seeking evaluation with the CCEP. This table shows the correspondence of codes between the 3 versions of the ICD codebook in use by the Army during the entire study period. Conditions are grouped by their major ICD groupings. xx% of the conditions fall within the psychiatric groupings, xx% are diseases of the musculoskeletal system and connective tissue, and xx% are symptoms, signs and ill-defined conditions.

--INSERT TABLE 1 HERE--

Figure 1 shows hospitalization rates for those conditions prevalent among GWE veterans across the entire Army, 1970-1998, and also dates of major deployments during this time period (To be added). Appendicitis rates have remained stable (113/100,000 hospitalizations in 1980 and 118/100,000 in 1997), and Gulf War prevalent conditions have declined (342/100,000 in 1980 and 240/100,000 in 1997). The hospitalization rates for Gulf War prevalent conditions among men and women are dramatically different, with women having a rate generally twice as high as men. There were historic peaks in rates of Gulf War

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prevalent conditions that coincided with the end of the Gulf War in 1991. Another idiosyncrasy of Army hospitalization patterns is the consistent drop off of rates for all hospitalizations in 1995. We have documented this in other analytic efforts as well. This is probably due to changes in administration of cases with much greater outsourcing of care to TriCare.

--INSERT FIGURE 1 HERE--

Figure 2 shows inpatient hospitalization and outpatient visit rates in 1998 for Gulf War prevalent conditions among the 1998 active duty population. Outpatient visits exceed hospitalizations for all diagnoses and are thus shown on a different scale in order to appreciate the relative proportions of outpatient to inpatient cases for specific causes. However, the ratio of inpatient to outpatient visits is not constant across diagnostic categories. For example, there are 39 outpatient visits to one inpatient visit for esophageal reflux (ICD-9-CM 530.81) and 19 outpatient visits to one inpatient visit for other and unspecified sleep apnea (ICD-9-CM 780.57). Other conditions, such as rash (ICD-9-CM 782.1), malaise and fatigue (ICD-9-CM 780.7) and lumbago (ICD-9-CM 724.2) have thousands more outpatient visits than inpatient visits. Conditions such as osteoarthritis (ICD-9-CM 715.90), and pain in joint (ICD-9-CM 719.40 and 719.49) were not seen in the hospital at all.

--INSERT FIGURE 2 HERE--

Table 2 shows percentages of GWE soldiers who remained on active duty per year for the seven years following the end of the conflict. By June 1994 more than half of the deployed soldiers had left the Army (51.4%) as compared to 47.6% of non-deployed GWE soldiers. The health status of these discharged veterans is not known. However, results from the match of active duty Army soldier data to VA Persian Gulf Registry data indicates that just over 3 percent (3.4%) of Army soldiers who did not seek evaluation in the CCEP did, nonetheless, seek care under the VA's Persian Gulf Registry. Though the percent is relatively small, the sheer number of individuals involved is large (N=27,215). In addition, the majority of

these individuals (70%) who ultimately ended up in the VA system after leaving the Army reported symptoms.

--INSERT TABLE 2 ABOUT HERE--

Figure 3 shows rates for inpatient hospitalizations for Gulf War prevalent conditions among deployed and non-deployed GWE veterans, stratified by type of medical facility in which they were treated (i.e., regional CCEP centers and other medical centers). Rates of admissions are highest in the facilities that did not conduct CCEP evaluations. There is a sharp decline in rates of admissions for the major medical centers between 1991 and 1992 but no similar decline in rates observed in the CCEP medical centers. There is a peak in rates for Gulf War prevalent conditions among deployed and non-deployed (particularly among the deployed) in June 1994 through June 1996, and rates for both deployed and non-deployed groups were similar through June 1998. Though the increased rates in 1994 were most pronounced among deployed soldiers non-deployed soldiers also experienced increased admissions in this time period in both CCEP facilities and major medical centers.

Rates for Gulf War Illnesses increased again in 1994 among both types of facilities. Just after the initiation of the Army's CCEP program in 1994, there was a rapid increase in hospitalizations for Gulf War prevalent conditions among soldiers who had deployed to the Persian Gulf. This was most evident in the facilities that did not complete CCEP workups.

The lower half of this figure also shows dates of events related to the Gulf War or Gulf War Illnesses, and the number of newspaper articles concerning Gulf War Illness (To Be Added). Large increases in hospitalizations began occurring with the first invasion of Kuwait and continued to increase until the last troops participating in the conflict returned home. The next peak, June of 1993, follows the first media coverage of a potential Gulf War Illness. The second peak following the Gulf conflict occurred in June 1994 and coincides with the institution of the CCEP. The third peak following the Gulf conflict occurred in June of 1996 and coincides with the first DoD report of destruction of chemical weapons dump at

Khamisiyah and the September 1, 1996, DoD letter sent to veterans notifying them of possible sarin exposure during the conflict.

--INSERT FIGURE 3 HERE--

Figure 4 shows trends in hospitalization rates for deployed and non-deployed soldiers and maps the media coverage concerning military downsizing and sexual misconduct. Each of the four peaks in hospitalizations was preceded by an increase in media coverage of military downsizing and base closings (To Be Added).

--INSERT FIGURE 4 HERE--

Discussion

These data provide some important heretofore-overlooked information about the trends in hospitalizations for Gulf War Illnesses.

The data also suggest that there is serious potential for a healthy worker bias. While percentages of soldiers who do not have CCEP data but who do, nonetheless, register with the VA Persian Gulf Registry program after leaving the Army are low, the actual numbers are quite high. These soldiers could be followed for later occurrences of Gulf War related conditions, but this cannot be easily accomplished because of current VA data policies. This suggests a need for a higher, policy level change that would facilitate better sharing of data between VA and DoD researchers while still protecting the anonymity of individual soldiers.

Thus, use of hospitalizations in order to evaluate Gulf War Illnesses will capture more serious cases of all conditions and in particular be likely to capture psychiatric disorders. Hospitalizations will capture fewer musculoskeletal disorders than outpatient data.

Thus, conditions commonly reported among veterans of the Gulf, but that often don't result in a hospitalization, such as joint pain, and other musculoskeletal conditions, may not be fully evaluated in studies that only use hospitalization outcomes.

These data also suggest that there are a number of factors that may influence rates of Gulf War prevalent conditions that do get hospitalized. The increase in rates among those not deployed may be a result of increased stress related to the war effort, related to the deployment of a spouse or friend, or may be simply an artifact of changes in hospitalization practices in reaction to fears about Gulf War Illnesses. Perhaps soldiers with conditions which are not normally worked up in a hospital setting were more likely to be hospitalized during the period following the war (regardless of deployment status) because of heightened sensitivity among the medical and command community.

Because hospitalizations are used as a measure of Gulf War Illnesses more psychiatric conditions are captured than some of the other common conditions diagnosed among veterans in an outpatient setting. Individuals are likely to be at greater risk for these sorts of conditions after experiencing stressful events including the threat of job loss through base closings, the notification of potential exposures and a "mystery illness," as well as actual exposure to combat in the Gulf. Because there were many potential factors influencing rates of illnesses it is possible that some of these events, including media coverage of downsizing and the Gulf, as well as changes in hospitalization practices, may have influenced rates of hospitalization for Gulf War Illnesses. The fact that the increased rates (the "peaks") are driven primarily by increased rates for conditions falling largely in the psychiatric group of illnesses—illnesses likely to be stress-related—provides more evidence of possible confounding. It is difficult to separate the effects of deployment from the influence of media hype, government notification of possible hazardous exposures, and external stressful events such as downsizing from deployment *per se* when evaluating the risk for developing illnesses commonly diagnosed among Gulf War veterans.

Conclusions

Tables and Figures

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Table 1 = Gulf War prevalent conditions, or the top 25 conditions reported by Army soldiers registering with the Comprehensive Clinical Evaluation Program (CCEP), with their ICD-9-CM codes and corresponding codes from the ICD-9 and ICDA8 codebooks.

ICDA-8	ICD-9	ICD-9-CM
		290-319
		Mental Disorders
		296.20 Major Depressive Disorder, Unspecified
		300.4 Neurotic Depression
		307.81 Tension Headache
		309.81 Prolonged Posttraumatic stress disorder
		311 Depressive Disorder, Not elsewhere classified
		320-389
		Diseases of the Nervous System & Sense Organs
		346.90 Migraine, Unspecified
		390-459
		Diseases of the Circulatory System
		401.9 Essential Hypertension, Unspecified
		460-519
		Diseases of the Respiratory System
		477.9 Allergic rhinitis, cause unspecified
		493.90 Asthma, Unspecified, without mention of status asthmaticus
		520-579
		Diseases of the Digestive System
		530.81 Esophageal Reflux
		564.1 Irritable colon
		680-709
		Diseases of the Skin and Subcutaneous Tissue
		692.9 Contact Dermatitis and other Ecze, Unspecified cause
		710-739
		Diseases of the Musculoskeletal System and Connective Tissue
		715.18 Osteoarthritis, localized, other specified sites
		715.90 Osteoarthritis, unspecified, multiple sites
		719.40 Pain in joint, site unspecified
		719.46 Pain in joint, lower leg
		719.49 Pain in joint, multiple sites
		724.2 Lumbago
		729.1 Myalgia and myositis, unspecified
		780-799
		Symptoms, Signs and Ill-Defined Conditions
		780.52 Other insomnia
		780.57 Other and unspecified sleep apnea
		780.7 Malaise and Fatigue
		780.9 Other general symptoms
		782.1 Rash and other nonspecific skin eruption
		784.0 Headache

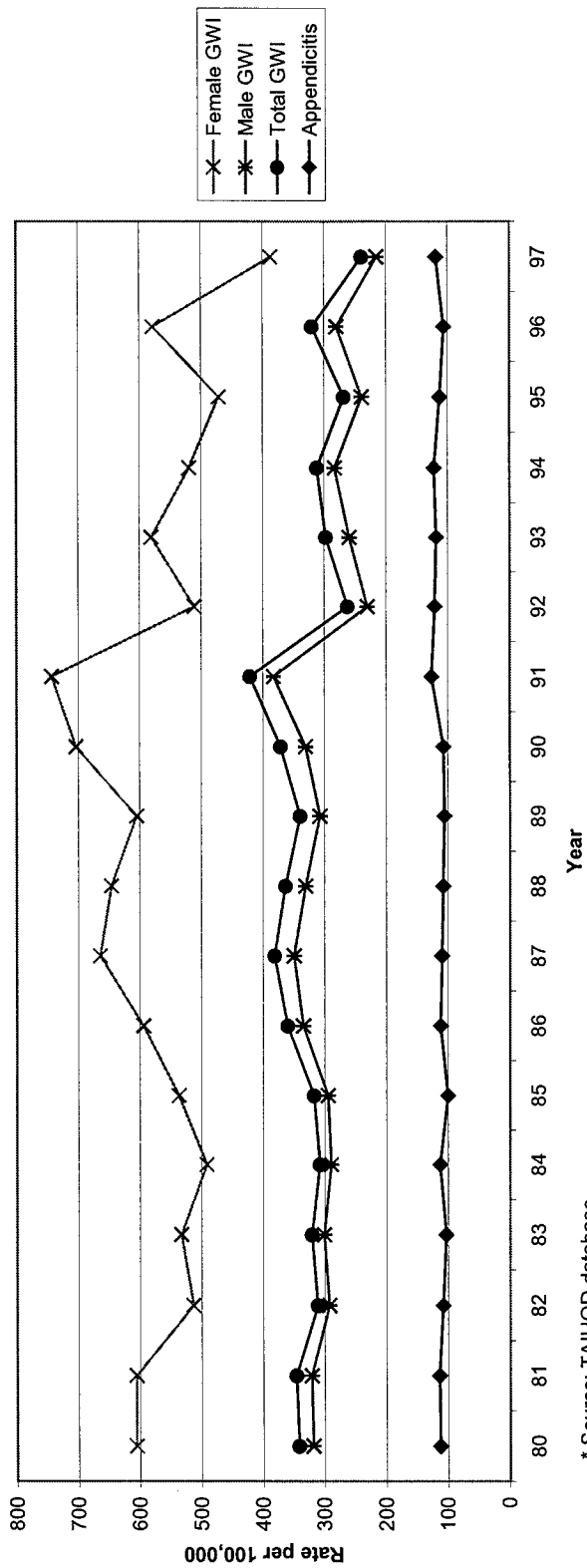
Source: Twenty-five most common final diagnoses among CCEP registrants, other than "healthy"

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Table 2 = Number and percentage of Gulf War Era veterans remaining on active duty, 1991-1997.

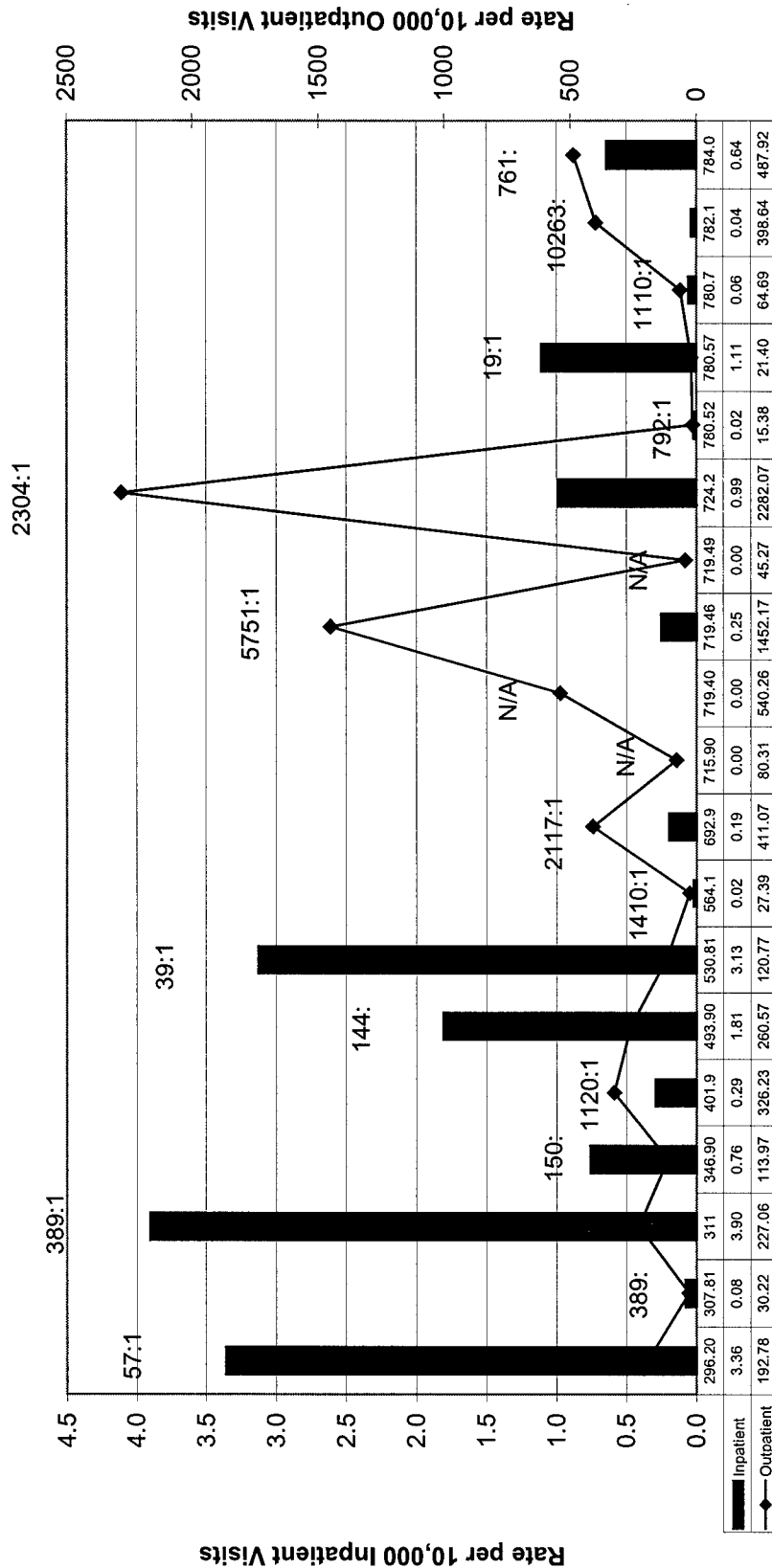
Year/Month	# Deployed on duty	% of Deployed on duty	# Non-Deployed on duty	% of Non- Deployed on duty
Jun-91	257699	100.0%	417927	100.0%
Dec-91	248016	96.2%	389579	93.2%
Jun-92	217104	84.2%	349899	83.7%
Dec-92	184054	71.4%	308453	73.8%
Jun-93	153624	59.6%	263432	63.0%
Dec-93	138806	53.9%	240258	57.5%
Jun-94	125316	48.6%	218798	52.4%
Dec-94	115850	45.0%	202817	48.5%
Jun-95	107370	41.7%	185893	44.5%
Dec-95	99514	38.6%	171112	40.9%
Jun-96	91777	35.6%	155822	37.3%
Dec-96	85749	33.3%	145754	34.9%
Jun-97	79586	30.9%	134710	32.2%
Dec-97	73990	28.7%	124825	29.9%

Figure 1. Rates of GWI Hospitalization and Appendicitis, 1980-1998
Population: Active Duty Army



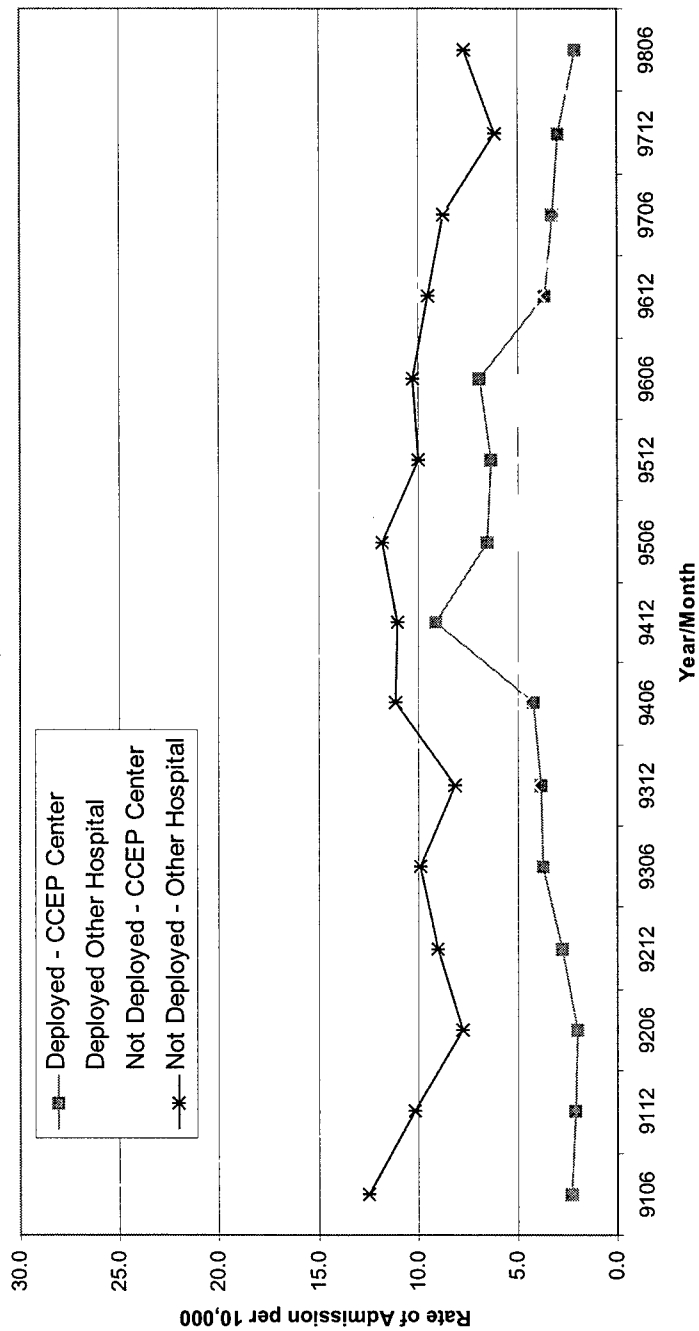
* Source: TAIHOD database.

Figure 2. Rate of Outpatient Visits vs. Hospitalizations for GWI
Ratio of Outpatient Visits:Inpatient Visits
Population: 1998 Active Duty Army



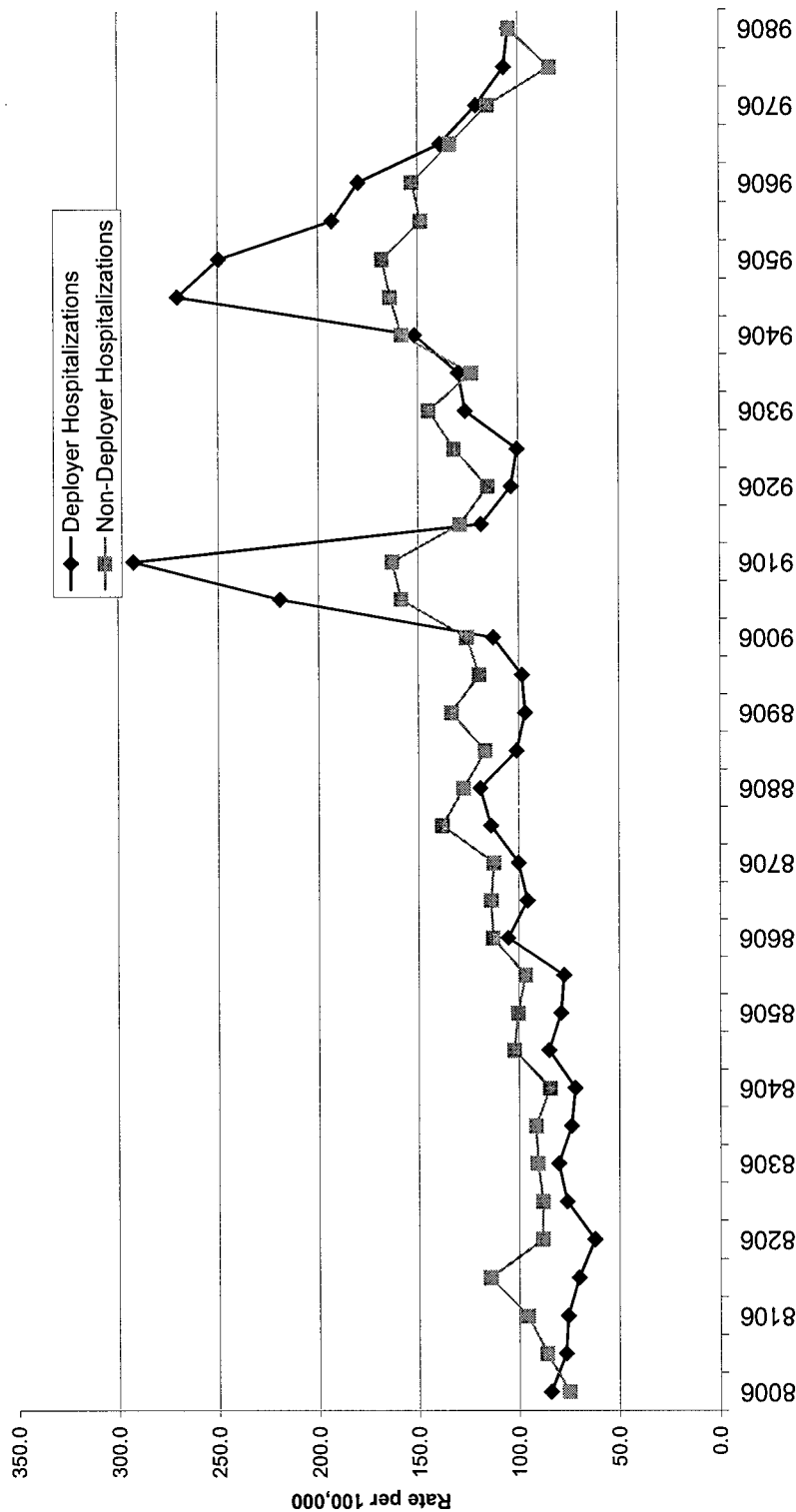
Source: DMED

Figure 3. Rate of GWI Admissions, CCEP Centers vs. Other Hospitals



Final figure will also include media coverage of Gulf War illnesses

Figure 4. GWI Hospitalization Rates of GW Era Veterans
Deployed Veterans vs. Non-Deployed Veterans



Final figure will include media coverage of external events (military downsizing and sexual misconduct in the
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Appendix C. Three decades of Army hospitalization data

Until recently, the TAIHOD had hospitalization data from the Patient Administration and Biostatistics Activity (PASBA) spanning the period from 1980 forward. In late 1999, hospitalization data for the years 1971-1979 was also added. Integration and interpretation of these data however has presented several important challenges.

The first challenge in using these hospitalization data stems from the Army's practice of including quarters cases and clinic visits in the database. Failure to adjust for these cases would result in an overestimate of the rates of hospitalizations in the early years. Figure C1 shows crude and unadjusted rates of hospitalizations for all conditions among all Army soldiers from 1971-1997. Rates are calculated as number of hospitalization records divided by the number of soldiers on active duty. The dotted line includes clinics/quarters cases, troop/health clinic visits, boarders, and day surgery cases. Including these cases inflates estimates of hospitalization rates dramatically.

Also noteworthy on this chart is the decline in rates for all hospitalizations beginning in the late 1990s. We suspect that this is partially due to national changes in admitting practices, but mostly related to the growing number of cases that are getting outsourced to TRICARE and are therefore not captured by the current Army databases that report the standard inpatient data records.

The third challenge in using these data revolves around changes to the practices of coding hospitalized conditions. The International Classification of Diseases (ICD) has undergone three major revisions in the past three decades. The Army used ICDA8 (the version of ICD adapted for hospital coding) from 1971-1979, and then inexplicably used the ICD-9 (generally only used for mortality coding) from 1980-1985. In 1986, the Army switched to ICD-9-CM (the clinical modification intended for hospital inpatient cases). As new versions of the ICD manual are released, codes for newly defined clinical outcomes have been added and codes for other conditions have been redefined to allow for greater specificity in coding. Figure C2 shows the rates of hospitalization for two types of traumatic injuries: knee and head injuries. The codes for these two groups of conditions have remained fairly stable over time. The dotted line corresponds to traumatic knee injuries, and shows little variation until the latter part of the 1990s, when outsourcing to TRICARE became more common for all conditions. On the other hand, there are other conditions whose codes have changed more dramatically over time. Figure C3 shows the rates of hospitalizations for two types of chronic musculoskeletal conditions: osteoarthritis and rheumatoid arthritis. The codes for these types of conditions have varied considerably over the past thirty years. Rates for both conditions show a precipitous drop-off in 1980 when the Army switched between two versions of the ICD codebook.

It is clear that changes in the coding system might impact rates of hospitalizations differentially for some types of conditions but not others. Having recognized this, we have been working with the National Center for Health Statistics and a professional nosologist in developing a scheme for mapping the coding of conditions over time. This effort will allow us to calculate rates of hospitalizations for conditions common among soldiers deployed to the Gulf as far back as 1971. By comparing the trend line of hospitalization rates to other historical events in the past three decades, we can see whether high rates of the symptom-based conditions or so-called Gulf War Illnesses occur in conjunction with other deployments (potentially including the latter part of the Vietnam era).

Figure C1. Hospitalization Rates for all active-duty Army soldiers, 1971-1997

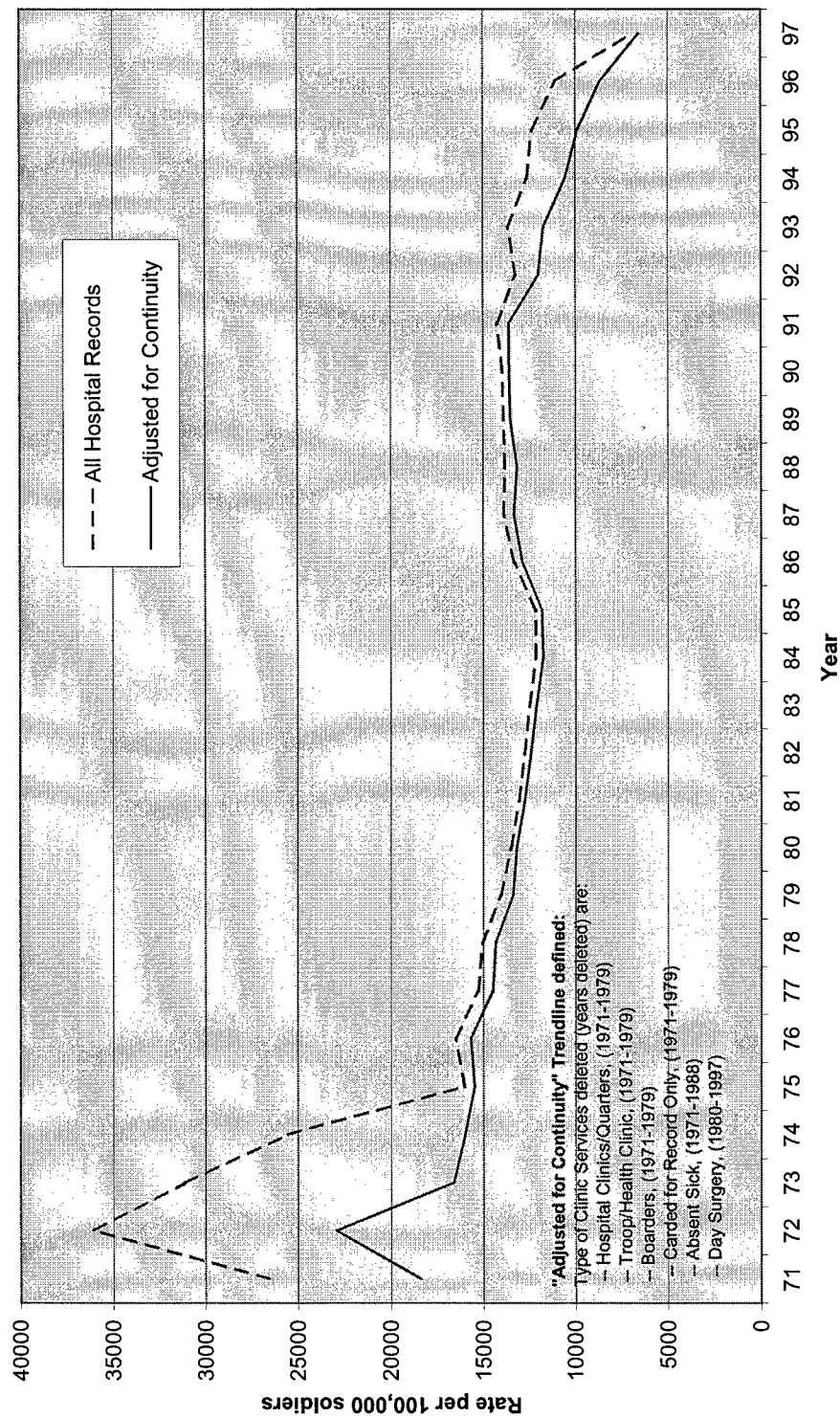


Figure C2. Hospitalization rates for traumatic knee injuries and traumatic brain injuries among active duty Army soldiers, 1971-1997

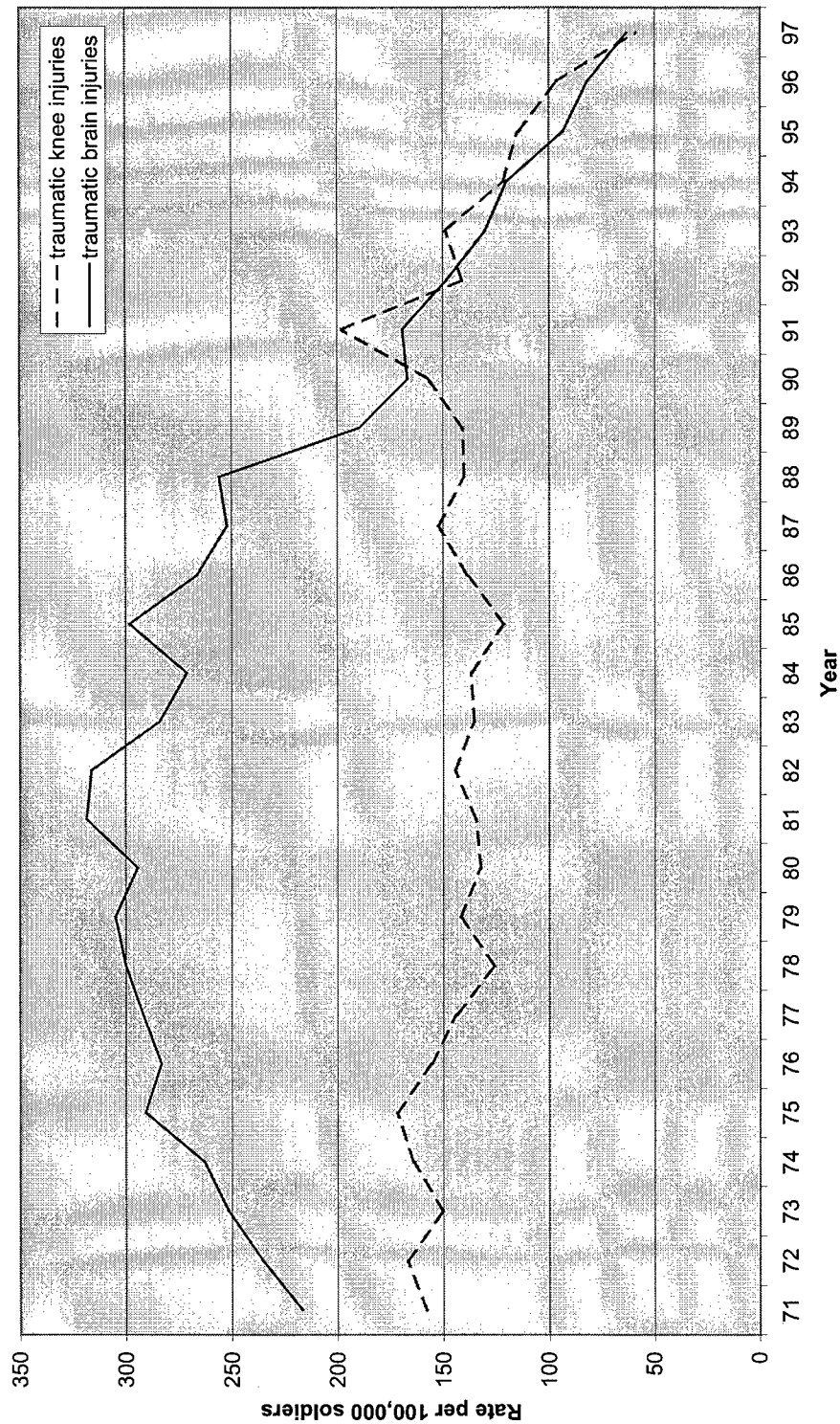
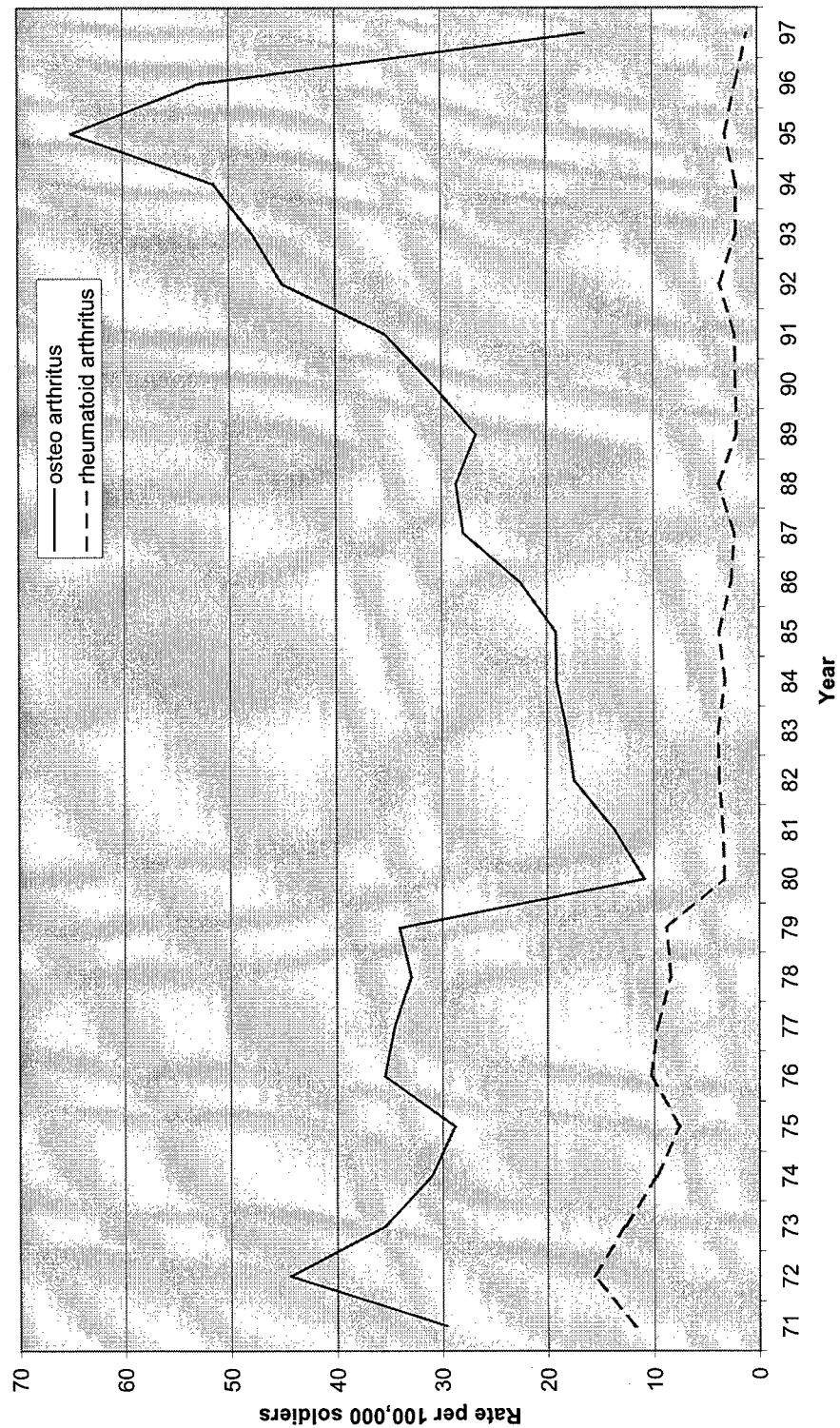


Figure C3. Hospitalization rates for osteoarthritis and rheumatoid arthritis among all active duty Army soldiers, 1971-1997



Appendix D. The link between situational stressors and risk for illness among Gulf War Era (GWE) veterans

We have constructed several variables that we hypothesize identify potentially stressful events in a soldier's life. One variable identifies changes that occur in marital status prior to or during the war, and associations with hospitalizations in the post-war period for a condition common among Gulf War veterans. Because DMDC records are captured at 6-month intervals in the TAIHOD we measured changes occurring between December 1989 and June 1990, and any second changes that occurred between June 1990 and December 1990. The outcome measure used consists of the top 25 conditions most common among Gulf War veterans who registered with the CCEP (excluding "normal"). For convenience we are referring to them in this document as "Gulf War Illnesses" or GWI. Results of this preliminary work are summarized below.

While these results are preliminary and do not control for potential confounders such as prior health status, they do suggest that individuals who experience stressful life events, such as multiple changes in marital status, may be at greater risk for hospitalization with a condition common among Gulf War veterans. Soldiers who experienced a change in marital status between December 1989 and June 1990 AND a second change between June 1990 and December 1990 ($n = 22,010$) were at roughly 3 times the risk for a subsequent hospitalization (between June 1991 and June 1994) as compared to soldiers who experienced only one change in marital status (between December 1989 and June 1990). On average 12% of soldiers who changed their marital status between December 1989 and June 1990 and then changed their status again between June 1990 and December 1990 were later hospitalized with a GWI. In contrast, about 4% of soldiers who experienced only one change in marital status (between December 1989 and June 1990 but not between June 1990 and December 1990) experienced a GWI hospitalization.

Similar results are seen, though less dramatic, when we examined changes in the number of dependents. Soldiers who experienced changes between 1989 and 1990 and again between June of 1990 and December of 1990 in their number of dependents had about a 50% greater risk for experiencing a GWI hospitalization than those soldiers whose number of dependents changed only once between December 1989 and June 1991.

We have also hypothesized that certain occupational factors (which may or may not also be related to likelihood of being deployed) may be associated with increased risk for the symptom-based ill-defined conditions often associated with deployment. For example, soldiers who are relatively new to a given rank might be expected to perform at a higher level than that which they have been accustomed. They may have new responsibilities that are stressful and which may affect their health. On the other hand, soldiers who are under stress may not perform well in their jobs. This is likely to be reflected in slow rates of advancement relative to their peers (though more sophisticated models are needed in order to control for the effect of different opportunities for advancement associated with different MOS jobs). Thus soldiers who have been in a given rank for a relatively long period of time might also be expected to experience greater risk for illness. We have begun testing this hypothesis by examining all deployed soldiers in enlisted ranks (E1-E9) stratifying them based upon their time in grade as of June 1990 from shortest to longest quintile. We have conducted univariate analyses to examine possible associations between this variable and risk for Gulf War-prevalent illness hospitalization within the three years following the Persian Gulf War (June 1991-June 1994). Table D1 shows preliminary results from this effort.

As we hypothesized (a priori) those in grade for an average amount of time appear to be at lowest risk for a Gulf War prevalent illness hospitalization though effect sizes are not large. Deployed soldiers on active duty for the median amount of time as compared to others of similar rank were at lowest risk of experiencing an illness.

Table D1. Time in grade and subsequent hospitalizations for Gulf War Illness in the postwar period, July 1991-June 1994 for Gulf War deployers.

Time in Grade	Number of deployed soldiers who experienced GWI hospitalization in postwar period (n = 218,810)		Row Totals (n's)
	Yes (%) (n=1,050)	No (%) (n=217,760)	
Shortest	0.48	99.52	45425
Medium-Short	0.50	99.50	47486
Average	0.45	99.55	44021
Medium-Long	0.49	99.51	41426
Longest	0.47	99.53	40452

Chi-square statistic = 32324, p<.005

Appendix E. Demographic, physical, and mental health factors associated with deployment of US Army soldiers to the Persian Gulf

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**Demographic, physical, and mental health factors
associated with deployment of US Army soldiers to the Persian Gulf**

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ABSTRACT

675,626 active-duty Army soldiers who were known to be at risk for deployment to the Gulf, were followed from 1980 through the Gulf War. Hospitalization histories for the entire cohort and Health Risk Appraisal surveys for a subset of 374 soldiers were used to evaluate *prewar* distress, health, and behaviors.

Deployers were less likely to have had any prewar hospitalizations, or a hospitalization for a condition commonly-reported among Gulf War veterans, or to report experiences of depression/suicidal ideation. Deployers reported greater satisfaction with life and relationships, but displayed greater tendencies toward risk-taking such as drunk-driving, speeding, and failure to wear safety-belts. Deployed veterans were more likely to receive hazardous-duty pay and to be hospitalized for an injury than non-deployed Gulf War era veterans.

If distress is a predictor of postwar morbidity it is likely due to experiences occurring during or postwar and not related to prewar exposures or health status. Postwar excess injury risk may be explained in part by a propensity for greater risk-taking, evident before, and persisting throughout the war.

INTRODUCTION

Nearly 700,000 American military personnel were deployed to the Persian Gulf between August of 1990 and April of 1991 in support of Operations Desert Shield/Desert Storm (ODS/DS), most of them Army soldiers. Soon after these soldiers began returning to the United States, reports of unexplained illnesses and nonspecific symptoms (later termed "Gulf War Illnesses") began to surface. After nearly 10 years of research and a great deal of media attention, the cause of these problems remains elusive.

One potential, though largely unexplored, explanation for the development of Gulf War-related illnesses is the possibility that pre-war characteristics (intrinsic or acquired traits) shared by soldiers deployed to the Gulf differ from those of soldiers not deployed. Understanding these differences may contribute to an improved understanding of why a variety of symptom complexes described as Gulf War-related illnesses have been reported among those soldiers who did ultimately deploy to the Gulf. At a minimum, the potential confounding influence of these possible differences deserves a comprehensive evaluation in current research efforts.

The purpose of this paper is to describe prewar demographic, occupational, and physical and mental health status of active duty Army soldiers who deployed to the Persian Gulf; and to compare these characteristics to soldiers on active duty who did not deploy.

BACKGROUND

Studies of Gulf War veterans have focused principally on postwar health outcomes. Few studies have compared the prewar experiences, health habits, and general mental and physical health status of veterans. Most significantly, few studies have explored how factors predicting deployment may confound or contribute to soldiers' risk of developing Gulf War-related illnesses subsequent to service in the Gulf. Documenting differences between soldiers based on whether they deployed or not may improve understanding of post-deployment soldier health.

Differences in demographic variables, health behaviors, risk-taking behaviors, mental or physical health could influence a soldier's postwar health status. Such factors could affect the chance of selection

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for deployment (e.g., risk-taking habits), risk of future illness independent of deployment (e.g., cigarette smoking), risk for responding to the deployment experience with increased risk-taking behaviors (e.g., postwar increases in alcohol use as a coping response).

During ODS/DS, deployed soldiers did not experience significantly higher overall mortality rates than non-deployed Gulf War era veterans, or the US population at large with the exception of unintentional injury death (1). Similarly, a study of postwar mortality found that deployed Gulf War veterans were significantly more likely to die from accidents, such as motor-vehicle crashes, than their non-deployed counterparts, but not from illness-related deaths (2). This suggests either risk-taking differences between deployed and non-deployed soldiers during and after the war or increased exposure to hazards. Since a veteran's experiences during the war might contribute to the adoption of unhealthy risk-taking behaviors after the war, it is important to look for the presence of these behaviors prior to deployment. Otherwise we will not be able to discern whether the war caused increases in risk taking, or whether prewar tendencies to engage in risky behaviors were in fact responsible for deployment. Similarly, suggestions that stressors or distress following service in the Gulf may predict Gulf War illnesses cannot be fully evaluated without exploration of mental health or experiences of stressors *prior* to deployment.

Studies published to date have primarily measured health outcomes among individuals assigned to one or more specialized military units, often relying on small samples (3-13), in groups of veterans seeking treatment for conditions they believed to be related to service in the Gulf (10, 14-16), or in veteran populations drawn from a particular geographic locale (7, 10, 17-22). Many studies relied heavily upon self-reports of symptoms and exposures, sometimes with little obvious efforts to validate the reports or the measurement instrument used (7, 9-13, 17-22). Pre-morbid data on the physical and mental health status of Gulf War veterans is severely limited. There have been few population-based surveys that have examined health-related trends across the entire Army, or that have been able to control for a large enough number of demographic variables to adequately assess the issue of who gets selected to deploy. This has resulted in an incomplete and potentially biased picture of the functional health status of Army Gulf War veterans, and has prevented a cogent assessment of the extent to which *prewar* factors affect a soldier's risk of developing Gulf War-related illnesses.

This paper expands upon existing knowledge by examining a broader range of prewar health status measures for all Army soldiers on active duty during the war, followed over a longer continuous prewar time-period. Also, this paper focuses specifically on the Army; a group known to be disproportionately high users of care for Gulf War health concerns (23). This study includes prospectively gathered information on a variety of mental health and risk-taking behavior measures.

METHODS

Study Population

675,626 active-duty Army soldiers were followed from 1980 or entry to the Army if they entered after 1980, to the beginning of the ODS/DS (August 1990). 257,699 of these soldiers ultimately were deployed to the Persian Gulf between August 1, 1990 and June 14, 1991. Only soldiers who remained on active duty for the full duration of ODS/DS (i.e., active-duty subjects, for whom we had confirmed demographic information at three observation points, June 1990, December 1990, and June 1991) were included in the cohort. An additional group of 160,812 soldiers were on active duty during some portion of the ODS/DS period but not for the entire period, seven and a half percent of which (12,098) were deployed to the Gulf. Because these individuals did not have the same opportunity to be deployed and were missing prewar information they were excluded from analyses. A sub-analysis of 374 members of the study population who took an Army Health Risk Appraisal (HRA) before the war began was conducted in order to assess differences in prewar risk taking, self-reported experiences of stressors, and feelings related to distress or depression.

The Data

The Total Army Injury and Health Outcomes Database (TAIHOD) (24, 25) was used to describe the study population's demographic, health, and behavioral characteristics. The TAIHOD joins key elements from multiple Department of Defense (DOD) administrative and health databases, linked at the individual soldier level by encrypted social security numbers. Components used in these analyses included demographic and occupational records, self-reported health behaviors and quality of life (Health

Risk Appraisal (HRA) surveys), hospitalizations, and health evaluations from the Comprehensive Clinical Evaluation Program for Gulf War veterans (CCEP¹). (24, 25)

The TAIHOD DMDC data are collected at six-month intervals, in June and in December of each year. Discharge ("loss") files are merged to these files to provide a complete occupational history for every active duty soldier. HRAs, officially implemented by the Army in 1987, but not administered in large numbers until 1991, have been administered to a subset of the Army during routine in-processing to new work assignments, as part of periodic physical examinations, physical fitness testing, or during walk-in visits at occupational or outpatient health clinics. Sociodemographic characteristics of those taking the HRA were similar to those in the study population who did not take an HRA, except that HRA takers were more likely to have some education beyond high school than were those in the overall cohort (38% versus 19% respectively). Also, enlisted soldiers who had completed an HRA were more senior than enlisted soldiers who did not complete an HRA (50% of HRA takers were E5 or above vs about 40% of those who did not take an HRA). These differences probably reflect in part longer time in the Army and thus greater opportunity to have been offered the HRA. While 13% of the overall study cohort had been in the Army for 1 year or less in June 1990, only 6% of those taking the HRA had been in the service for a year or less. Perhaps more importantly, though, those taking the HRA were no more likely to have had a prior hospitalization than those who did not take an HRA, suggesting similar health status (data not shown).

Variables for Analysis

The main outcome measure for these analyses is deployment to the Persian Gulf. The DMDC Gulf War deployment file was used to determine if a soldier was deployed to the Gulf War theatre of operations. For this analysis, deployment was defined by being sent to the Gulf War theatre at anytime between August 1, 1990, and June 14, 1991.

Demographics: Demographic information included gender, age, race, education, marital status, number of dependents, rank, total active duty service, and occupation (DoD occupational code).

¹ The CCEP was established in June 1994, upon the directive of the Department of Defense, in order to evaluate Gulf War veterans who were concerned about their health, and to facilitate treatment for the myriad of complaints and conditions experienced by Gulf War veterans.

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Demographic data from the June 1990 DMDC files are used for most analyses. For logistic regression models of prewar annual hospitalization risks, demographic data from the first observation point in each year are used.

For ease of analysis and interpretation, age is grouped as <21, 21-25, 26-30, 31-35, 36-40, and >40 years of age. Racial or ethnic groups are described as white, black, Hispanic, Asian/Pacific Islander, Alaskan/Indian, and other. Education is coded as less than a high school degree, high school degree or equivalent (GED), some college, bachelor's degree, any graduate education, and other. Marital status is coded as single (never married), no longer married, married with spouse not on active duty, married with spouse on active duty but not deployed to the Gulf, or married with spouse on active duty and deployed to the Gulf. Dependent status was coded as member only, member with one dependent, or member with two or more dependents. Military rank is coded as junior enlisted (E1-E4), senior enlisted (E5-E9), warrant officers, junior officers (O1-O3), officers (O4-O5), and senior officers (O6-O11). Total time on active duty was calculated from entry into the service until June, 1990 and grouped as follows: <6 months, >6-12 months, >12-24 months (1-2 years), >24-60 months (2-5 years), >60-120 months (5-10 years), >120 months to 180 months (10-15 years), >180 months to 240 months (15-20 years), and greater than 240 months (over 20 years).

Some military soldiers receive hazardous duty pay as partial compensation for their occupational exposures. Hazardous duty pay is received by flight crew, parachutists, divers, those assigned to war zones (combat pay) or foreign duty, and those exposed to environmental stressors or experimental vaccines. Hazardous duty has been linked in prior research to increased risk of injury (26). For this study, hazardous duty pay was coded as: not-receiving hazardous duty pay, or receiving one type of hazardous duty pay only, or receiving two or more types of hazardous duty pay concurrently between January 1, 1990 and June 30, 1990. Thus, hazardous duty compensation received in this time period reflects exposures *prior* to ODS/DS.

Occupations were grouped using the Department of Defense (DoD) occupational codes². DoD occupational codes are broad occupational categories comprised of similar Military Occupational Specialties (MOS). Occupational specialties available differ by rank and often by gender. The categories

² DoD 1312.1-I, Occupational Conversion Index. Enlisted/Officer/Civilian, March 1997

for enlisted personnel include infantry/gun crews, electrical equipment repair, communications/intelligence, health care, technical/allied specialists, support/administration, mechanical equipment repair, crafts workers, service/supply, and non-occupational. Warrant and commissioned officer categories include general officer/executive, tactical operations officer, intelligence officer, engineering and maintenance officer, scientists and professionals, health care officers, administrators, supply/procurement and allied officers, and non-occupational.

Health & Health Behaviors: The hospital and HRA components of the TAIHOD were used to document prewar health status. Hospitalizations were examined in three overlapping categories, any cause, injuries (ICD-9-CM 800-999), and conditions most commonly observed among Army Gulf War veterans evaluated for Gulf War related health concerns³. Though there is no clear consensus from the medical community on what constitutes a "Gulf War Illness," in order to evaluate the incidence of prewar conditions commonly diagnosed among veterans of the war we used the 25 most frequent ICD-9-CM diagnoses (other than "healthy") among Army veterans registered with the CCEP who received a clinical evaluation. These Gulf War-prevalent illnesses are referred to as Gulf War Illnesses (GWI) throughout this text. Hospitalization with a primary diagnosis including any of these conditions was used to indicate a GWI hospitalization independent of deployment status. Any hospitalization occurring prior to August 1, 1990 was included for analysis with the earliest hospitalization cases occurring in 1980. For purposes of these descriptive analyses, hospitalizations were counted once per individual in each of the three categories.

Stressors, distress, risk-taking propensity, and general mental well being were assessed through several HRA variables. We grouped six variables assessing behavioral risk for alcohol dependence into

³ Major depressive disorder, single episode (296.20), neurotic depression (300.4), tension headache (307.81), prolonged post traumatic stress disorder (309.81), depressive disorder, not elsewhere classified (311), migraine, unspecified (346.90), essential hypertension, unspecified (401.90), allergic rhinitis, cause unspecified (477.9), asthma, unspecified (493.90), esophageal reflux, without inflammation (530.81), irritable colon, not elsewhere specified (564.1), contact dermatitis and other eczema, unspecified cause (692.9), primary localized osteoarthritis (715.18), osteoarthritis, unspecified whether generalized or localized (715.90), unspecified arthralgia (719.40), lower leg arthralgia (719.46), multiple site arthralgia (719.49), lumbago, not otherwise specified (724.2), myalgia and myositis, unspecified (729.1), other insomnia (not otherwise characterized), (780.52), other and unspecified sleep apnea (780.57), malaise and fatigue (780.7), other general symptoms which may include amnesia (retrograde), chills not otherwise specified, generalized pain, hypothermia not related to low environmental temperature, (780.9), rash and other non-specific skin eruptions (782.1), and headache, including facial pain and other pain in the head that is not otherwise specified (784.0) (TAIHOD Database, May 1999).

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one single index measure because intercorrelations were quite high (coefficient alpha = 0.763) and all of the items appear to be measuring risk for dependent drinking (face validity). The resultant composite alcohol use measure comprised the 4 CAGE items (27) and two additional, similarly scaled items: "friends worry about your drinking," and "ever have a drinking problem." The CAGE is a clinical screening tool used to identify individuals at risk for alcohol dependency. Thus we refer to the composite variable (CAGE plus the two related items) as a potential "dependent drinking" measure. This composite item has been shown to be a better predictor of high risk drinking and other risky behaviors than the CAGE alone (28). Survey-takers missing responses to three or more of the items were excluded (18%). The remaining items were used to develop an average response. These responses were dichotomized, based upon the distribution of responses for the entire population, into two categories: those with no affirmative responses (84%) versus those with 1 or more affirmative responses. Risky driving practices were also grouped to improve power and because any one of the three high risk driving habits measured in the HRA could increase risk for motor vehicle injuries—the only source for differences in mortality between Gulf War era veterans who were deployed versus those not deployed to the Gulf (2, 29). This variable included drinking alcohol before driving or riding with someone who had been drinking, speeding, and seatbelt usage. Very few soldiers were missing responses to any of these items ($n = 6$). Those that were missing responses to any of these items were dropped from the analysis. The final variable was coded as yes (if the subject said he or she had done any drinking and driving or had ridden with an intoxicated driver one or more times in the past month; or if the subject said he or she routinely drove more than 5 miles per hour over the speed limit, or if he or she reported using a safety belt less than 100% of the time on average).

Other variables used for analysis included feeling so overwhelmed the respondent had considered hurting him or herself, considering suicide or experiencing prolonged depression within the past year, experiencing worries that interfered with life, problems with spouse, children or peers, work stress, low satisfaction in current job assignment, low life satisfaction, frequent losses in past year, and little time for relaxation. We also included self-reported daily tobacco use and weekly alcohol consumption.

Analytic Methods

Exploratory analysis was conducted using frequency distributions and Chi-square tests. Continuous variables were compared using t-tests. To compare prewar differences in health behaviors, and experiences of stressors and distress between deployed and non-deployed cohorts, Chi-square analysis was used. Multiple logistic regression analyses, with deployment as an outcome, were conducted in order to explore the relationships between the explanatory variables. Occupation, gender, and rank were highly correlated. Therefore we constructed different models, selecting the most commonly deployed occupational groups in each gender-rank group for comparison purposes.

To compare differences between deployed and non-deployed cohorts in their risk for hospitalization before the war, while controlling for differences in exposure potential (time in service), multivariate Cox proportional hazard models were used. Soldiers were followed from entry into the Army (or from January 1, 1980 for those who entered the Army before 1980) until their first hospitalization event occurred or until August 1, 1990 (censored date). In 1990, only hospitalizations occurring before August 1, 1990 were included for comparison, as this was one day before Iraq's invasion of Kuwait and one week before the arrival of US planes in Saudi Arabia. Thus, we hope to reduce potential bias that might result if an individual sought hospitalization to avoid deployment.

To identify changes in risk for hospitalizations as a function of time and proximity to the deployment period, logistic regression models predicting hospitalization for any cause, for injuries, and for GWI were also constructed for each year in the prewar period. Beginning in 1980, models compared rates in each year for soldiers who ultimately deployed to those who did not deploy. The potentially confounding influences of gender, age, race/ethnicity, time in active military service, education, and rank were included in the models.

SAS was used to develop multivariate models and initial exploratory models (30). Bivariate associations between self-reports on the HRA and deployment status were evaluated using EpiInfo (31). Exact odds ratios, confidence intervals, and two-sided p-values were used, since many of the tables included sparse cells.

RESULTS

There were 675,626 Army soldiers on continuous active duty during ODS/DS. Thirty-eight percent (257,699) were deployed to the Persian Gulf between August 1, 1990, and June 1, 1991.

Unadjusted analyses revealed that deployers were more likely to be male, have fewer than five years of time in service, be under 25 years of age, black, single, high school graduates, have fewer dependents, and be junior enlisted and junior officer rank, than their non-deployed counterparts (Table 1). Thirty-nine percent of men on active duty during the war deployed compared to 29% of the women on active duty; 46% of those under age 21 deployed compared to 28% of those over age 35; and almost half of those enlisted with a grade of E1-E4 (45%) deployed compared to 10% of officers with a grade of O6-O11 (data not shown).

Deployers were also more likely to have received hazardous duty pay *prior to* July 1990 (See Table 1). Deployed enlisted soldiers were more likely to be in infantry/gun crews, mechanical equipment repair, or crafts worker (e.g., plumbers, metal workers) occupations. Deployed officers were significantly more likely to belong to the tactical operations or supply and procurement, engineering and maintenance or intelligence officer occupational group. Deployed warrant officers were significantly more likely to be in the tactical operations occupational groups.

-- Insert Table 1 here --

In Table 2 we investigate whether demographic characteristics described in Table 1 are independent predictors of deployment in multivariate logistic regression models. Because gender, rank, and occupation are highly correlated (with numerous potential occupational categories) we conducted separate sub-analyses based on occupations most commonly deployed to the Gulf within each gender-rank group. The results from these multivariate logistic regression models show factors explaining variation among those who deployed and those who did not deploy in occupations with the highest rates of deployment to the Gulf.

Factors consistently associated with deployment across all four occupations included younger age (mostly less than age 25), less time in service (particularly those in the service less than 5 years),

having fewer than 2 dependents, and having a spouse on active duty who was also deployed to the Gulf. Also, those with less education were more likely than their more highly educated counterparts to deploy. Enlisted male and female soldiers of lower rank were significantly more likely to be deployed than their higher-ranking counterparts. This was also true of female officers but not male officers. Male enlisted and male officers with special pay for exposure to two or more occupational hazards were more likely to deploy than males in these same occupations who had received no hazardous duty pay.

-- Insert Table 2 here --

Three hundred and seventy-four of the 675,626 soldiers on active duty during ODS/DS had taken an HRA taken prior to August 1, 1990. Deployers were less likely to have seriously contemplated suicide or to have experienced prolonged or repeated periods of depression within the past year. They were *less* likely to say that life had been so overwhelming they had considered hurting themselves, worries had ever interfered with their daily lives, they were not satisfied with their life or jobs, they had experienced family problems or personal misfortunes, or that they never had time to relax. They were also *less* likely to answer affirmatively to the dependent drinking measure. Similarly, those who deployed were more likely to say they had experienced a *pleasant* life change in the past year. Though the direction of these associations is consistent, we are unable to rule out the role of chance in these associations due to small sample sizes and tight control of Type I and II errors.

A trend was observed suggesting that those who deployed are more likely to engage in risky behaviors such as drinking alcohol before driving, speeding, and are less likely to wear their seatbelts while driving.

-- Insert Table 3 here --

In multivariate Cox proportional hazards models (controlling for gender, age, race, education, marital status, time in service, rank, and prewar receipt of hazardous duty pay) deployed status remained significantly associated with *reduced* risk for a hospitalization for any cause or for one of the conditions commonly documented among Gulf War veterans, though the risk differences were quite small. There was no significant difference in risk of injury hospitalization between deployed and non-deployed Gulf War era veterans. Male gender, young age, less education, single marital status, less time in service, and receipt of two or more types of hazardous duty pay in a pay period were all significant predictors of

prewar injury hospitalization (data not shown).

Figures 1-3 depict the association between deployment and adjusted odds of hospitalization during each year of the follow-up period. Figure 1 shows that deployers were at lower risk for hospitalizations due to any cause, particularly in the period immediately before ODS/DS, even after controlling for gender, age, race/ethnicity, time on active duty, education, and rank.

-- Insert Figure 1 Here --

Deployed soldiers were not at greater risk for a prewar GWI hospitalization than were non-deployed Gulf War era veterans. There was a largely consistent pattern of risk in the prewar period where those who ultimately deployed were actually at *lower* risk for a hospitalization related to any of the diagnoses most commonly seen among veterans seeking care for GWI after the war (Figure 2).

-- Insert Figure 2 Here --

In most years prior to ODS/DS deployers were at greater risk for an injury hospitalization than were their non-deployed counterparts. This was true even after accounting for the effects of gender, age, race, time in service, education, and rank (Figure 3). To refine this analysis we also constructed an age-specific model including just soldiers under age 26. Even among this very young cohort, injury risk in almost every year prior to ODS/DS was significantly higher among soldiers who ultimately deployed than among those who did not (data not shown).

-- Insert Figure 3 Here --

DISCUSSION

Without good, prewar baseline information it is difficult to make a cogent assessment about the postwar health consequences of service in the Persian Gulf. There have been relatively few studies documenting prewar health and mental status of soldiers deployed to the Persian Gulf. The few studies that have focused on or at least briefly described differences between those who deployed and those who did not deploy to the Gulf note that veterans deployed to the Gulf were disproportionately male and younger than veterans deployed elsewhere (1, 18, 23). They were also more likely to be married than their non-deployed counterparts, and differed significantly with respect to race or ethnicity, branch of service, activation status (e.g., reserve vs. active duty) and grade (1, 18, 23). Deployed veterans were

more likely to be discharged or separated from the military soon after the war, although not because of death or medical disability (23). Gray et al. also note that military personnel who were sent to the Gulf had fewer prewar hospitalizations up to the point of deployment than their non-deployed counterparts, particularly in the years immediately preceding ODS/DS, similar to what we document among active duty Army (23). We expand upon these earlier observations by examining a longer time period and by including an assessment of prewar risk-taking differences, self-appraised distress and well being, and by focusing on active duty Army. We also expand upon the strengths of earlier studies by using a comparison group that was more restrictive than that used by many other researchers. We reduce potential bias by only including non-deployed Gulf War era veterans who were on active duty throughout the entire ODS/DS period.

Our data suggest that before the war Army soldiers who ultimately deployed to the Persian Gulf were significantly healthier and happier than their non-deployed counterparts, as measured by their hospitalization histories and self-reports. They were significantly less likely to report prewar experiences of depression or suicidal ideation and they were significantly less likely to have experienced any prewar hospitalizations and, most noteworthy, hospitalizations for conditions most prevalent among postwar Army veterans seeking care. The data also suggest that deployed personnel were happier in their personal lives (families, life events) and jobs prior to the war than their non-deploying counterparts. Though small sample sizes limited our ability to detect statistically significant differences in many cases between the two cohorts, the consistency of the findings across measures of satisfaction and general well being is compelling.

There is some evidence indicating that soldiers who deployed to the Gulf may have been greater risk takers prior to deployment, and/or may have faced greater hazards than non-deployed Gulf War era veterans. They were more likely to have received hazardous duty pay for 2 or more different hazardous exposures *before* being deployed to the Gulf War theatre. These prewar differences are driven primarily by more frequent receipt of pay for parachuting or for potential exposure to hostile fire. Indeed, these attributes or experiences might make the candidates likely prospects for wartime deployment.

Other evidence for excess prewar risk taking or risk exposure among deployers can be found in the records of prewar hospitalizations and self-reported behaviors. For most years between 1980-1990

annualized odds for injury hospitalizations were higher than for those not deployed, even after adjusting for potential confounders. Similarly, non-significant trends were observed which suggested that soldiers deployed to the Gulf were also more likely to speed, drive after having had too much alcohol, or ride with someone who had consumed too much alcohol, and were less likely to always wear their seatbelt.

Those who were deployed to the Gulf were significantly more likely to also have a spouse who was deployed. This may be an important modifying factor, and should be considered in future studies examining risk factors for Gulf War-related illnesses. This seems particularly important given the findings of Gray et al. who note that even after controlling for several confounders married personnel were at greater risk for postwar hospitalizations for all causes (23). Perhaps those who were married are at greater risk for postwar hospitalizations because they were likely to have a spouse also deployed to the Gulf. These veterans might be experiencing even greater distress due to concerns about the well being of their deployed spouses.

There are a few potential weaknesses of this study that deserve comment. First, because the HRA program was initiated in late 1987 there are relatively few HRAs in the prewar time period, with the bulk of those used in this study coming from the years 1989 and 1990. However, because we are interested in prewar experiences of stressors or distress, and health habits as they relate to postwar health, the close proximity of HRA measures we do have to the start of the ODS/DS period may also be considered a strength of this study. In addition, in spite of small samples we are still able to demonstrate a significant difference in risk for depression and suicidal ideation in the prewar period. Second, the measures of health behaviors and life quality from the HRA are self-reported and cannot be directly validated by assessment of actual practices and life stressors. However, many studies have validated self-reported behaviors and found good correspondence between actual and reported behaviors (32-38). The use of hospitalization diagnoses common among Army CCEP registrants may reduce generalizability of our findings as not all veterans of the Persian Gulf chose to register or receive clinical evaluation under the CCEP program. Finally, the cohort defined here includes those who were on active duty for the entire ODS/DS period. Thus, individuals who enlisted during the war or who were discharged during the war are not included.

CONCLUSIONS

It seems unlikely, given these data, that any single prewar factor, such as excess stress, distress, difficulty coping, or poor health, will completely explain the health concerns and illnesses Gulf War veterans have experienced since the war. Our results suggest that the elevated distress among Gulf War veterans compared to non-deployed Gulf War era-veterans found in some studies (22, 39-41) is probably best understood as a consequence of the war experience rather than due to elevated pre-war levels of distress. However, the excess postwar injury mortality may be due to risk-taking habits or exposures that were present prior to deployment and which persisted even after the war. Though there is some cohesive evidence for excess risk taking among deployers prior to the war, the strength of the evidence is weak. More information is needed documenting postwar risk-taking habits, particularly longitudinal data capable of documenting changes in habits that may have occurred after deployment.

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TABLES AND FIGURES

Table 1. Unadjusted associations between the demographic characteristics of 675,626 Army Gulf War era veterans and deployment to the Persian Gulf*

	Deployed (N=257,699) %	Not Deployed (N=417,927) %	Chi-Square P Values
Gender			
Male	91.64%	87.12%	<.001
Female	8.36%	12.88%	
Age‡			<.001
<21 years	15.04%	11.07%	
21-25 years	37.15%	28.09%	
26-30 years	22.58%	21.94%	
31-35 years	13.56%	17.64%	
36-40 years	7.92%	12.50%	
>40 years	3.75%	8.73%	
Race/Ethnicity			<.001
White	60.85%	62.82%	
Black	30.67%	28.63%	
Hispanic	4.15%	3.96%	
Asian/Pacific Island	1.43%	1.82%	
Indian/Alaskan	0.56%	0.50%	
Other	2.32%	2.24%	
Educational Level			<.001
Less than high school	1.21%	0.89%	
High school graduate/GED	84.35%	75.29%	
Alternate education	0.03%	0.03%	
Some college	3.43%	4.94%	
Bachelors degree	7.75%	10.98%	
Graduate degree	2.10%	6.67%	
Unknown	1.13%	1.22%	
Marital Status			<.001
Single	43.31%	34.00%	
Married, spouse not on active duty	49.93%	56.98%	
Married, spouse on active duty & deployed	1.95%	0.95%	
Married, spouse on active duty & not deployed	1.57%	3.65%	
No longer married	3.20%	4.27%	
Unknown	0.03%	0.15%	
Dependents			<.001
Member only	44.93%	36.65%	
Member +1 dependent	17.57%	17.50%	
Member +2 or more dependents	37.32%	45.56%	
Unknown	0.19%	0.29%	
Rank			<.001
E1-E4	54.39%	41.33%	
E5-E9	34.92%	41.41%	
Warrant Officer	2.20%	1.95%	
O1-O3	6.53%	9.08%	
O4-O5	1.77%	5.26%	
O6-O11	0.18%	0.97%	
Time in Service			<.001
Less than 6 months	3.99%	4.50%	

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	Deployed (N=257,699) %	Not Deployed (N=417,927) %	Chi-Square P Values
6-12 months	10.94%	7.89%	
>12-24 months	16.31%	10.88%	
>24-60 months	31.71%	26.20%	
>60 - 120 months	18.34%	20.13%	
>120 - 180 months	11.10%	15.59%	
>180 - 240 months	6.31%	11.27%	
> 240 months	1.26%	3.49%	
Unknown	0.03%	0.05%	
Hazardous Duty Pay			<.001
No hazardous duty pay	86.41%	87.08%	
Hazardous duty pay 1 type	12.81%	12.37%	
Hazardous duty pay 2 or more types in pay period	0.78%	0.55%	
Enlisted (n=575,942)			<.001
Infantry/Gun crews	27.58%	24.34%	
Mechanical equipment repair	18.99%	13.38%	
Communication/ Intelligence	14.01%	14.13%	
Support/ Administration	12.17%	18.26%	
Service/ Supply	11.76%	11.15%	
Health Care	5.09%	8.24%	
Electrical equipment repair	4.60%	5.29%	
Technical/ Allied specialist	2.93%	2.96%	
Craftworkers	2.61%	1.77%	
Non-occupational	0.25%	0.44%	
Other	0.01%	0.03%	
Officer (n=85,874)			<.001
Tactical operations officer	40.86%	27.02%	
Non-occupational	12.10%	19.06%	
Health care officers	12.10%	18.91%	
Supply, procurement & allied officers	10.37%	7.11%	
Engineering & maintenance officer	10.35%	8.54%	
Intelligence officer	5.24%	4.50%	
Administrators	4.90%	7.40%	
Scientists & professionals	3.78%	6.79%	
General officer/Executive	0.26%	0.52%	
Other	0.05%	0.15%	
Warrant (n=13,810)			<.001
Tactical operations officer	49.09%	37.77%	
Engineering & maintenance officer	26.44%	25.37%	
Supply, procurement & allied officers	7.76%	7.42%	
Non-occupational	4.91%	6.31%	
Intelligence officer	4.38%	7.34%	
Health care officers	3.77%	3.75%	
Administrators	3.49%	11.28%	
Scientists & professionals	0.14%	0.64%	
Other	0.02%	0.12%	

* Values are those documented in June 1990 DMDC records.

‡ Chi-Square test for trend analysis indicated a statistically significant trend of increasing risk for deployment with successively younger age groups with the odds for deployment being more than 3 times greater among those under age 21 as for those over the age of 40 (p <.001).

Table 2. Multivariate logistic regression analyses of individual characteristics related to deployment to the Persian Gulf. By occupation-rank-gender groups most often deployed to the Gulf (Odds ratios for deployment and 95% confidence intervals)

	Infantry & Gun Crews N=146,864 (Male Enlisted)	Support & Administration N=25,248 (Female Enlisted)	Tactical Operations N=31,427 (Male Officer)	Health Care N=4,566 (Female Officer)
Age				
17-20 years	2.5 (2.3-2.7)	2.8 (2.2-3.5)	3.0 (0.9-9.4)	N/A
21-25 years	2.4 (2.3-2.6)	2.3 (1.8-2.8)	4.3 (3.9-4.7)	2.1 (1.6-2.7)
26-30 years	1.8 (1.6-1.9)	1.9 (1.5-2.4)	3.3 (3.1-3.6)	1.4 (1.1-1.8)
31-35 years	1.4 (1.3-1.5)	1.5 (1.2-1.8)	2.0 (1.8-2.1)	1.3 (1.0-1.7)
36-40 years	1.2 (1.1-1.3)	1.1 (0.9-1.4)	1.9 (1.7-2.1)	1.0 (0.8-1.3)
>41 years	1.0	1.0	1.0	1.0
Race/Ethnicity				
White	1.0	1.0	1.0	1.0
Black	1.0 (1.0-1.0)	1.1 (1.1-1.2)	0.9 (0.8-1.0)	0.9 (0.7-1.2)
Hispanic	1.0 (0.9-1.0)	1.3 (1.1-1.5)	0.8 (0.7-1.0)	1.0 (0.5-1.9)
Indian/Alaskan	1.0 (0.9-1.2)	1.1 (0.8-1.6)	1.1 (0.8-1.6)	0.7 (0.2-3.2)
Asian/Pacific Islander	0.9 (0.8-1.0)	0.8 (0.7-1.0)	0.8 (0.6-1.0)	0.7 (0.4-1.3)
Other	1.0 (0.9-1.0)	1.1 (0.9-1.4)	0.9 (0.7-1.1)	0.8 (0.4-1.6)
Education				
Less than high school	2.9 (1.7-4.9)	4.7 (1.7-13.3)	2.3 (0.4-13.8)	N/A
High school graduate/GED	2.8 (1.7-4.7)	3.3 (1.4-7.6)	3.8 (3.3-4.3)	N/A
Alternate education	3.0 (1.4-6.2)	N/A	N/A	N/A
Some college	1.9 (1.1-3.2)	2.2 (1.0-5.3)	3.0 (2.7-3.4)	N/A
Bachelor's degree	2.0 (1.2-3.4)	2.1 (0.9-5.1)	2.1 (1.9-2.2)	2.1 (1.8-2.5)
Graduate degree	1.0	1.0	1.0	1.0
Marital Status				
Single	1.5 (1.5-1.5)	1.3 (1.2-1.4)	1.5 (1.4-1.6)	1.4 (1.1-1.7)
Married, spouse not on AD	1.0	1.0	1.0	1.0
Married, spouse on AD, not deployed	0.7 (0.7-0.8)	0.5 (0.4-0.5)	0.9 (0.7-1.1)	0.7 (0.5-1.0)
Married, spouse on AD, deployed	2.4 (2.0-2.9)	2.7 (2.5-3.0)	3.9 (2.8-5.3)	1.9 (1.3-2.6)
No longer married	1.0 (0.9-1.1)	0.8 (0.7-0.9)	1.0 (0.9-1.2)	1.3 (1.0-1.7)
Dependents				
Member only	1.6 (1.6-1.6)	1.3 (1.3-1.4)	1.7 (1.6-1.8)	1.7 (1.4-2.1)
Member + 1	1.3 (1.3-1.3)	1.1 (1.0-1.2)	1.6 (1.5-1.7)	1.1 (0.9-1.5)
Member + 2 or more	1.0	1.0	1.0	1.0
Rank				
E1-E4	1.6 (1.6-1.6)	1.6 (1.5-1.7)	N/A	N/A
E5-E9	1.0	1.0	N/A	N/A
O1-O3	N/A	N/A	0.8 (0.8-0.9)	10.4 (2.5-42.2)
O4-O5	N/A	N/A	0.4 (0.4-0.4)	6.3 (1.5-25.7)
O6-O11	N/A	N/A	1.0	1.0
Time in Service				
<6 months	2.2 (1.9-2.4)	4.6 (1.8-11.7)	1.9 (1.3-2.8)	1.0 (0.4-2.3)
6-12 months	3.2 (2.9-3.6)	5.4 (2.1-13.5)	5.5 (4.6-6.6)	3.2 (1.6-6.2)
>12-24 months	2.9 (2.6-3.2)	7.0 (2.8-17.6)	5.7 (5.0-6.5)	3.2 (1.7-6.2)
>24-60 months	2.8 (2.5-3.1)	4.1 (1.6-10.3)	4.5 (4.0-5.1)	2.6 (1.4-5.0)
>60 - 120 months	1.8 (1.7-2.1)	3.6 (1.5-9.1)	2.9 (2.6-3.3)	2.5 (1.3-4.7)
>120 - 180 months	1.6 (1.4-1.7)	2.6 (1.0-6.4)	2.6 (2.3-2.9)	1.8 (0.9-3.5)
>180 - 240 months	1.3 (1.1-1.4)	1.8 (0.7-4.7)	1.9 (1.6-2.1)	1.6 (0.8-3.2)
> 240 months	1.0	1.0	1.0	1.0
Hazardous Duty Pay				
No hazardous duty pay	1.0	1.0	1.0	1.0
Hazardous duty pay 1 type	0.8 (0.8-0.9)	0.8 (0.7-0.9)	2.0 (1.8-2.2)	0.3 (0.0-2.2)
Hazardous duty pay 2 or more types in pay period	1.4 (1.3-1.5)	0.2 (0.0-1.7)	5.1 (2.9-8.8)	N/A

Table 3. Prewar, self-reported depression, distress, stress, and risk-taking behaviors and univariate associations with deployment to the Persian Gulf among 374 Army soldiers completing an HRA prior to August 1, 1990. Percent of deployed and non-deployed Gulf War era veterans reporting risk factors and odds ratios for the risk factor (deployed versus non-deployed).

Risk Factor	Deployed (n=106) %	Non- Deployed (n=268) %	OR**	95% C.I.	2-tailed p-value
Reports considering suicide or reports experiencing prolonged/repeated periods of depression in past year (vs. never)	20%	31%	0.56	0.31-0.99	0.04
Reports feeling so overwhelmed with life he/s considered hurting self in past year (vs. never)	2%	4%	0.45	0.05-2.13	0.37
Reports worries have interfered with daily life over past year (vs. never)	44%	49%	0.83	0.51-1.34	0.42
Reports having had serious problems dealing with spouse, parents, children, or friends (vs. never)	62%	70%	0.70	0.43-1.16	0.14
Reports feeling only somewhat or not satisfied at all with life in general (vs. mostly or totally satisfied)	14%	20%	0.66	0.33-1.26	0.19
Reports having experienced personal misfortune in past year (vs. none)	53%	61%	0.73	0.45-1.18	0.17
Reports feeling they are not satisfied with their current job (vs. somewhat, mostly, or totally satisfied)	67%	72%	0.77	0.44-1.37	0.34
Reports feeling there is sometimes too much work stress (vs. never)	73%	68%	1.23	0.72-2.12	0.43
Reports he/s seldom or never has time to relax (vs. sometimes or often)	14%	17%	0.87	0.42-1.65	0.62
Responds yes to 1 or more dependent drinking measures (vs. "no" to all)	11%	18%	0.55	0.25-1.21	0.11
Reports current smoking habits as Current-Smoker Ex-smoker (vs. never smoked)	21% 21%	22% 22%	0.93 0.90	0.50-1.71 0.48-1.65	0.82 0.90
Reports he/s has often or sometimes experienced pleasant life change in past year (vs. seldom or never)	62%	39%	1.45	0.89-2.37	0.11
Reports engaging in at least 1 high risk driving practice in past month or typically (vs. none)*	53%	46%	1.34	0.83-2.16	0.20

* Reports drinking and driving 1 or more times in past month, or speeding more than 5 miles over the limit, or not wearing seat belt 100% of the time.

** Exact methods used to calculate odds ratios, 95% confidence intervals and p-values (31)

Figure 1. OR and 95% CI for deployment status (outcome= any prewar hospitalizations 1980-1990) controlling for gender, age, ethnicity, total time in service, education, and rank

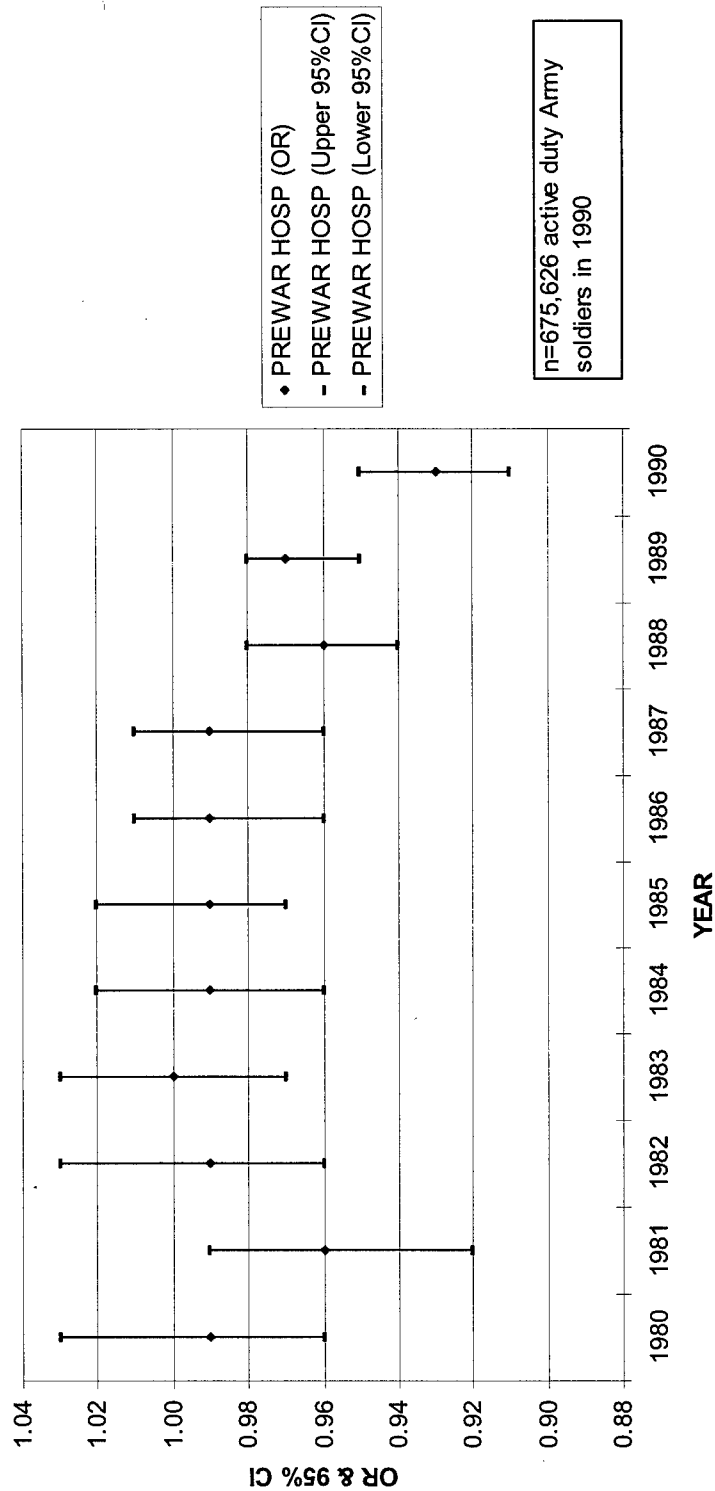


Figure 2. OR and 95% CI for deployment status (outcome = prewar GWI hospitalizations 1980-1990) controlling for gender, age, ethnicity, total time in service, education, and rank

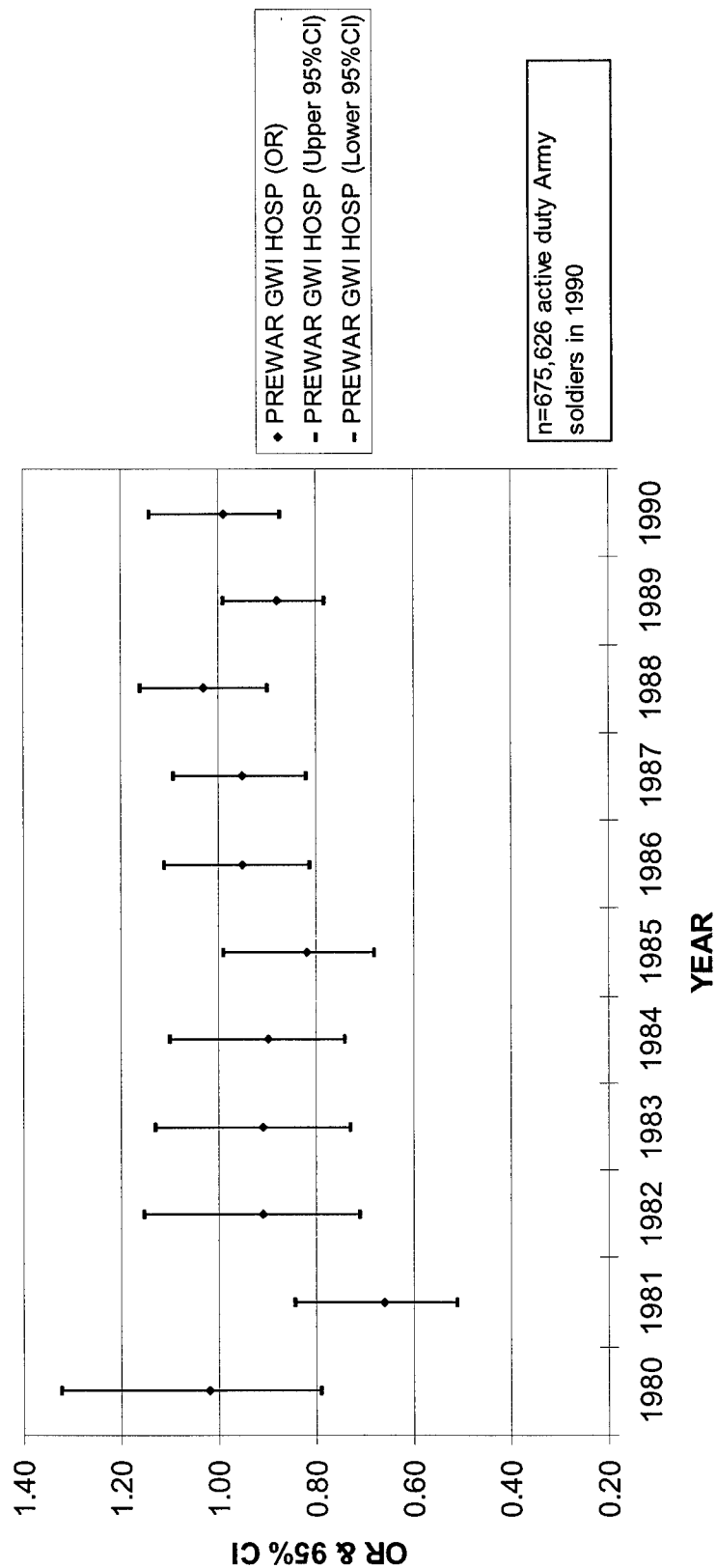
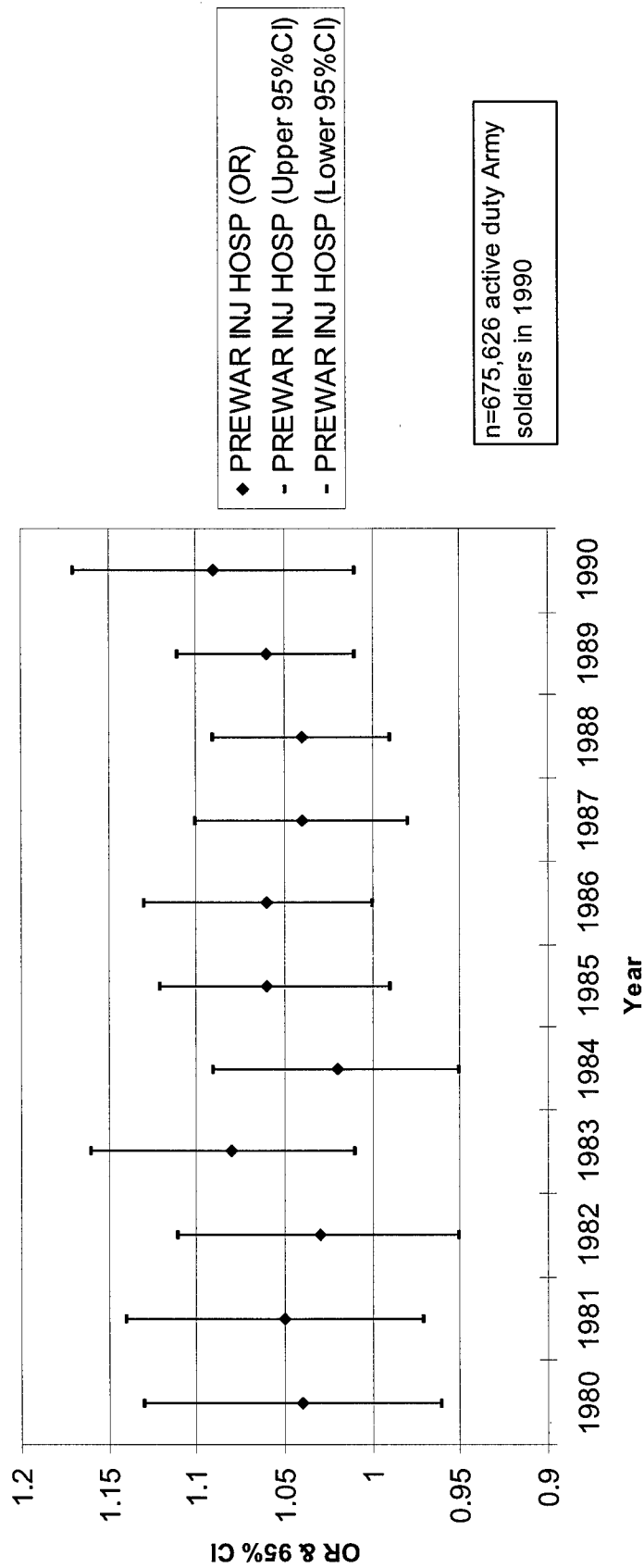


Figure 3. OR and 95% CI for deployment status (outcome = prewar injury hospitalizations 1980-1990) controlling for gender, age, ethnicity, total time in service, education, and rank



Appendix F. Commentary: Excess injury morbidity among veterans of the Persian Gulf War: A model of proposed etiologic pathways

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**Excess injury morbidity among
veterans of the Persian Gulf War:
a model of proposed etiologic pathways**

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Abstract

Death rates among US veterans of the Persian Gulf War were lower than rates among non-deployed veterans and the US population at large, with the exception of deaths due to injuries. Returning veterans were at significantly greater risk of injury mortality. A similar pattern of excess injury mortality was observed among US and Australian veterans returning from Vietnam. In spite of these consistent findings little has been done to identify the etiology of these associations and in particular to determine whether or not, and how, war-related exposures influence injury risk among veterans returning home after deployment to war environments.

We propose several potential pathways through which injury might be related to deployment. First, the process that selects certain individuals for deployment may lead to a spurious association between deployment status and injury mortality by preferentially selecting individuals who are risk-takers and/or exposed to greater hazards. Second, increases in injury mortality may be a consequence of depression, PTSD, and symptoms of other psychiatric conditions developed after the war. Third, physical and psychological traumas experienced during the war may result in the postwar adoption of "coping" behaviors that also increase injury risk (e.g., heavy drinking). Finally, the increased risk of injury could be the indirect consequence of increased experiences of ill-defined diseases and symptoms reported by many returning veterans.

More research is needed to clarify the link between deployment to a war environment and post-war increased risk of injury. More attention to this problem is needed from policy makers and researchers.

Key Words:

Behavior, Death, Military, Persian Gulf, Veteran, War, etiology

Introduction

In 1990, the United States and her military partners led a combined force against Iraq during Operation Desert Shield/Desert Storm (ODS/DS). Shortly after the war, participating soldiers began to report high rates of chronic, unexplained illnesses, which they believed might have been related to their service in the Gulf (1-8). There has now been more than a decade of extensive public debate, congressional hearings, clinical evaluations, and research culminating in the expenditure of approximately one billion dollars (US) (LTC James R. Riddle, U.S. Air Force, Office of the Assistant Secretary of Defense, Clinical and Program Policy, Pentagon, Oral Communication, 13 January, 2000). In the aftermath of this impressive effort, however, non-battle injury remains the only documented cause of increased post-war mortality among the soldiers who fought in the Gulf (9-11). Even *during* ODS/DS unintentional non-battle injuries were a more common cause of fatality than battle-related injuries or illnesses (12, 13). However, the increased risk for injury fatality has not been evaluated for etiologic or preventive factors.

Little information has been published regarding non-fatal injury among soldiers who deployed to the Gulf as well. We do know that non-fatal unintentional injuries and musculoskeletal conditions (which are often related to "old" injuries) comprised the single greatest category of outpatient visits during the war, caused the largest number of days lost from duty, and was the most common reason for evacuation from the Gulf (13, 14). A 1996 report found a slight, nonsignificant increase in risk of postwar injury hospitalization among deployed veterans as compared to nondeployed veterans (15). A more recent study that attempted to link active duty records to civilian and Veteran's Administrative data also suggests a post-deployment excess injury risk (16). Given that deployed veterans are at greater risk of fatal injury it seems likely that injury morbidity will also be greater. But, because there have been so few studies investigating injury morbidity among ODS/DS veterans, we do not know how the frequency or severity of injuries differ for deployed U.S. veterans. Even less is known about possible increases in injury among U.S. military allied forces.

The link between deployment to war zones and subsequent increases in non-battle injuries is not unique to ODS/DS. Symptoms and health outcomes commonly reported by veterans of ODS/DS, including injuries, are similar to those reported by veterans of other conflicts (17). For example, U.S.

veterans of the Vietnam conflict also experienced greater risk for injuries resulting from motor-vehicle crashes, poisonings, fires and burns, homicide, and suicide after returning home (18-26). An Australian study found that injury accounted for 74% of the post-war mortality among their soldiers who served in Vietnam (27).

As with ODS/DS, attention from the media, policymakers, and researchers on the problems of Vietnam veterans focused almost exclusively on health outcomes *other* than the observed increased risk of injury mortality. Indeed, many of the mortality studies among Vietnam veterans were initiated in response to concerns from veterans about a possible relationship between exposure to herbicides and elevations in cancer risk, and only found the excess risk of injury serendipitously (18-21, 23, 28).

Hypothesized Etiologic Pathways

There are several ways in which deployment to a hostile environment may directly or indirectly increase risk of injury after redeployment. Figure 1 details five possible pathways, with appropriate references to known factors that support their theoretical basis.

-- INSERT FIGURE 1 HERE --

1. One possible explanation for excess injury morbidity is the potential for bias related to selecting individuals for deployment who are inherently at greater injury risk. This increased injury risk may stem from a number of baseline personality or occupational characteristics such as: risk taking behaviors; belonging to an occupational group with documented hazards (e.g., vehicle drivers); or other baseline characteristics (e.g., smoking, alcohol consumption). These factors could elevate risk of experiencing an injury event and/or result in a poorer outcome after the event (e.g., smokers are more likely to experience stress fractures, and take longer to heal than nonsmokers)(29, 30).

There is little baseline information available that would allow exploration of pre and post-war risk-taking habits and injury predisposition among Gulf-War Era veterans. It is plausible, however, that the same factors that make a soldier a likely candidate for deployment to the Gulf may also be associated with greater risk of injuries independent of the war. Soldiers who are sensation-seekers or risk takers

may be more inclined to self-select to serve in the Gulf or to be employed in occupational specialties with a higher likelihood of deployment (e.g., Infantry, Airborne, Rangers, and Special Forces). Our investigation demonstrates that soldiers who received special hazardous-duty pay for activities such as parachuting or exposure to enemy fire in the period well before the start of ODS/DS were the same ones most likely to be deployed to the Persian Gulf, even after controlling for occupation (31). Bricknell et al. have also documented increased injuries among Army infantry who collect hazardous-duty pay as compared to infantry who do not collect this special pay (32).

2. Higher rates of injury mortality may be a consequence of increases in depression, PTSD, or other psychiatric conditions subsequent to service in the Gulf (9). Such conditions have been documented among U.S., British, and Danish veterans of the Gulf War (5-8, 33-41). Studies of other populations in non-military contexts have documented a link between psychologically distressed states, such as depression, and subsequent risk for self-inflicted injury (42-51). For example, suicide risk and PTSD were greatest among Vietnam veterans who had been wounded during battle and/or had experienced psychological trauma while in Vietnam (24-26). These states may also lead to increased risk for unintentional injuries. Depression, for example, may slow response time, and is associated with the use of alcohol. The association between alcohol use and injuries has been well documented in the literature. Comorbidities of depression and alcoholism are known to increase risk for suicide (52, 53).

3. The physical and psychological traumas experienced during war may result in the postwar adoption of potentially unhealthy "coping behaviors." Several studies have documented an association between exposures to emotional or physical trauma and increased use of alcohol or other substances (54-58). Changes in behavior may result from postwar depression or related conditions, or from attempts to self-medicate in order to alleviate symptoms. They may also occur independent of any diagnosed illness or condition yet still be an indirect consequence of an experience occurring in the Persian Gulf. For example, perceived near-death experiences have been shown to result in profound changes in values, beliefs, and behaviors as they relate to living and dying (59-61). Such changes might result in more reckless behavior and less regard for personal safety.

4. Increased risk of injury may be the indirect consequence of the ill-defined diseases and symptoms reported by many veterans, including fibromyalgia, chronic fatigue syndrome, and symptoms

such as dizziness, shakes or tremors, unrefreshing sleep, fatigue, muscle and joint pain, and confusion (2, 3, 62-69). These conditions may result in reduced response time or an inability to safely negotiate out of a hazardous situation (e.g., motor vehicle collision avoidance). Alternatively or concurrently, a veteran suffering from these conditions might be more likely to make decisions that may increase exposures to hazardous circumstances. For example, they may be more inclined to enter a quarrel, which could escalate to interpersonal violence. Thus far, the documented association between service in the Gulf and increased injury mortality has not been evaluated to determine if certain sub-groups (e.g., those suffering from multisymptom illnesses) are responsible for the observed differences in injury risk.

5. Finally, Kang and Bullman report only an excess of injury *mortality* (9). Without an understanding of the prevalence of *non-fatal* injury among deployed and non-deployed Gulf War era veterans it is impossible to ascertain whether or not veterans are at increased risk for injury events or whether they are at increased risk for death (or poorer outcomes in general) once they are injured.

Psychological distress, coping behavioral responses, and illness-symptoms may all act as modifiers of an injury event. A veteran of ODS/DS who incurs a postwar injury may be more likely to experience adverse sequelae than an injured veteran who was not deployed to the Gulf, due to the presence of war-related co-morbidities.

Increased injury frequency or severity may stem from any of these five proposed etiologic pathways, some combination of these pathways, or some other yet undiscovered pathway. In any case, injuries need to be further studied and should be added to the list of "Gulf War Illnesses and Conditions" so that the research effort is inclusive of all adverse health outcomes documented among ODS/DS veterans.

Barriers to the study of deployment related injuries

Despite evidence for the association between military deployment and excess injury, most research has focused on the search for a unifying case definition of "Gulf War Illnesses," and a search for an etiologic pathway, or several pathways, to explain the myriad of symptoms and conditions reported by veterans of ODS/DS. While the importance of these chronic multisymptom illnesses and the disability and suffering experienced by veterans should not be minimized, the lack of attention paid to the risk

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factors that contribute to elevated injury mortality, and to designing and implementing interventions to reduce injury mortality in this group of veterans is puzzling.

One of our top research priorities should be the examination of the plausible hypothesis that excess rates of postwar injuries are the direct result of experiences, or the indirect result of exposures, that occurred during service in the Gulf. Other researchers and agencies have also expressed this sentiment (70, 71). To date, however, with the exception of the five studies that describe the excess risk for non-battle injury mortality (9, 11-14), discussion and review of injury among Gulf War veterans has been limited to studies describing battle-related injuries and/or their psychological sequelae (72-85). Few resources have been devoted to this issue; of the billion dollars spent to date on research related to ODS/DS veterans' health, only a small proportion has gone to the study of excess injury. Though one study is currently being conducted to evaluate motor vehicle injuries in this population (86), we are not aware of any projects underway at this time that will clarify the specific etiologic pathways leading to elevated injury mortality among deployed veterans.

In June 1999, Gulf War researchers, veterans, and policy makers met at a conference to discuss key findings in the ongoing investigation of Gulf War Illnesses (87). Presenters noted that injuries remain the only documented cause of increased mortality among ODS/DS veterans (10, 88). However, in discussions of the research priorities identified for the near term injury prevention and etiologic studies were conspicuously absent. Similarly, several recent articles describe efforts currently underway and/or proposed for the near future to understand the chronic multisymptom illnesses and conditions experienced by ODS/DS veterans. Consistently, however, only passing mention is made of the documented excess injury mortality rate among ODS/DS veterans (89, 90). While there has been some effort to increase the study of injury etiology and prevention in the military at large, ironically the relationship between deployment to war and peacekeeping missions, and the non-battle injuries that occur during and after deployments, are not receiving appropriate emphasis (13, 91, 92).

A thorough examination of the relationship between deployment and injuries is undoubtedly hampered by the misperception that injuries are the end result of random, uncontrollable events. This fatalistic view is archaic and must be overcome. Injuries, like diseases, follow describable and predictable patterns. Interventions can be designed and implemented to modify individual and

environmental factors in such a way as to reduce the incidence of injuries (93, 94). The Navy, for example, succeeded in reducing Class A aviation crashes from 55 per 100,000 flying hours to only 3 per 100,000 flying hours over the past fifty years (91). This impressive decline in loss of life and property has been accomplished through engineering changes (e.g., the angling of aircraft carrier decks) and persistent systematic application of training and safety initiatives (95). Another example can be found by examining unintentional poisonings among children in the United States. Poisonings from drugs and medications declined by 50 percent in the first three years after childproof caps were required in 1973(96). Similarly, studies have shown remarkable declines in fire- and burn-related injuries in communities that have instituted programs to distribute smoke detectors to residences (97, 98). Simple measures such as these, conscientiously applied and appropriately monitored, have been repeatedly shown to reduce morbidity and mortality from injuries.

A related explanation for the relative lack of attention to injury mortality is that veterans who suffer from ill-defined conditions and symptoms have lobbied for research devoted to finding a cure or improved treatment for ailing veterans. By contrast, families of those killed in motor vehicle crashes or other injury events, veterans' advocacy groups, or even injured veterans themselves may not lobby for increased research into injury prevention if they too subscribe to the misconception that injuries are the end result of random events. Likewise, self-inflicted injuries may appear to have no external cause at all, mistakenly placing the blame on the individual.

The link between deployment and injury may not be readily identified in part due to the way injury is usually treated. In a clinical setting, acute trauma is managed almost entirely in emergency departments and acute care clinics where there may be little continuity of care and therefore no discovery or cause for investigation of a potential common pathway. Unless the physicians treating victims of acute trauma broaden their understanding of the risk factors that might predispose a patient to injury to include deployment-related conditions, there will be little impetus to study injury etiology among veterans in greater depth.

Recommendations for future studies

The military has made significant progress in recent years in recognizing the extent and severity

of the injury problem across all branches of the armed forces. There is now a large corps of researchers who are studying costs and the impact injuries have on the mission and readiness of the military. Three important publications have emerged in the past few years documenting the epidemiologic evidence that has come to light as a result of these efforts: the *Atlas of Injuries in the U.S. Armed Forces*, the report of the Armed Forces Epidemiological Board, *Injuries in the Military: A Hidden Epidemic*, and a supplement to the American Journal of Preventive Medicine devoted to the topic of injuries in the military (99). The fruits of these epidemiologic labors are beginning to be harvested, as the military has begun to develop effective injury prevention programs and policies. For example, the Army found a significant reduction in ankle injuries among parachutists wearing over-the-boot ankle braces and now issues such braces as part of the standard equipment for paratrooper trainees (100). In a randomized controlled trial, the Air Force discovered that neck-strengthening exercises reduced the incidence of neck injuries among F-16 pilots (101). The Navy's total-health screening protocol, the Sailor's Health Inventory Program, screens recruits for injury risk factors, such as alcohol abuse, and counsels them on ways to reduce their injury risk (102). These efforts are laudable, and demonstrate that the military is moving in the right direction by recognizing and documenting the extent of the problem, and putting programs in place to reduce injury risk in all branches of the armed forces. However, what is lacking is a comprehensive research plan or program to explore the causes and prevention alternatives for the specific deployment-related injury excesses that have been repeatedly identified. A concerted effort is essential if we are to determine the etiology of elevated injury risk among this special subgroup of deployed soldiers, whose risks are unlikely to be identified through the existing efforts and who will very likely require specially tailored intervention efforts.

Those interested in exploring the link between war exposure and non-battle injuries, and in designing prevention programs, need better information about the etiology of the increased injury risk among veterans. The following appear to be important steps in this effort: document the incidence of non-fatal injury among deployed and non-deployed veterans both in the U.S. and abroad; explore the role of risk taking behaviors prior to and subsequent to deployment; determine whether there are sub-populations at unique or particular risk for behavior changes; identify potential modifying factors that protect individuals from injury or suffering poor outcomes after injury; identify associations between post-

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deployment mental health and injury; and evaluate the association between injuries and the symptom-based conditions commonly experienced by ODS/DS veterans. Longitudinal data sources that include measures of behavior before and after ODS/DS, though hard to come by, would be particularly useful. Focus groups or similar qualitative assessment tools may also provide important insights into risk-taking habits and changes in safety-related behaviors among Gulf War veterans.

Since injuries are more easily identified and measured than, perhaps, multi-symptom illnesses, research into risk factors and effect modifiers may be quite cost-effective and result in more immediate health improvements for veterans of the Gulf War as well as those deployed in future conflicts and peacekeeping missions. These efforts are also likely to result in significant cost-savings to the federal government. There are currently more than 2.2 million people receiving disability compensation from the Veteran's Administration, about a third of whom have musculoskeletal system disabilities and receive direct payments of well over four billion dollars per year (103). The vast majority of disability discharges due to musculoskeletal conditions are the end result of injuries that occurred while in the military (104).

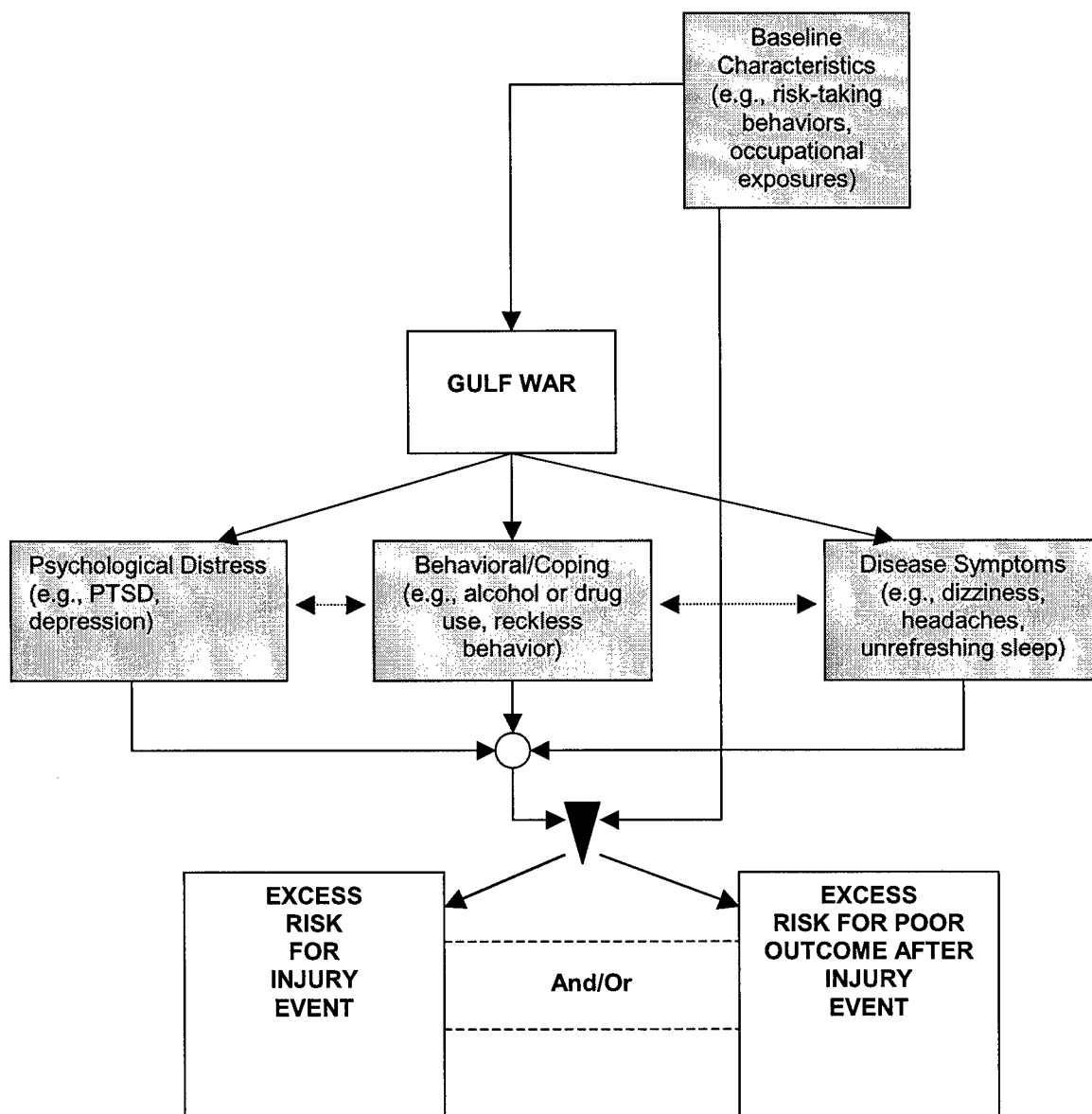
In order to begin thinking about interventions, we first need to conduct well-designed studies to identify risk factors for injuries among veterans. This will not happen with a restrictive focus on chronic multisymptom illnesses to the exclusion of injuries. Non-battle injury must be seen as a condition potentially related to deployment. There must be high-level support for injury research in this population. Finally, there must be a reevaluation of the current research agenda and a re-prioritization of related activities.

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Figure 1. Potential etiologic pathways for the association between service in the Persian Gulf and injuries



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DEPARTMENT OF THE ARMY
US ARMY MEDICAL RESEARCH AND MATERIEL COMMAND
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REPLY TO
ATTENTION OF:

MCMR-RMI-S (70-1y)

21 Feb 03

MEMORANDUM FOR Administrator, Defense Technical Information
Center (DTIC-OCA), 8725 John J. Kingman Road, Fort Belvoir,
VA 22060-6218

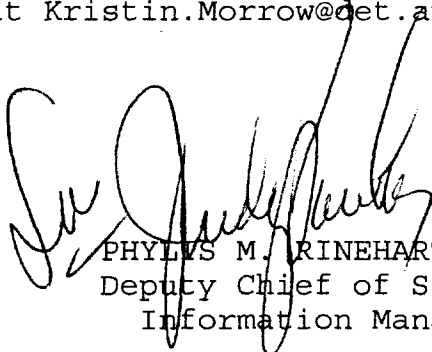
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1. The U.S. Army Medical Research and Materiel Command has reexamined the need for the limitation assigned to technical reports written for this Command. Request the limited distribution statement for the enclosed accession numbers be changed to "Approved for public release; distribution unlimited." These reports should be released to the National Technical Information Service.

2. Point of contact for this request is Ms. Kristin Morrow at DSN 343-7327 or by e-mail at Kristin.Morrow@det.amedd.army.mil.

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